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ICE HOUSES.

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U. S. Department of Agriculture

BY

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LETTER OF TRANSMITTAL.

U. S. Department of Agriculture,
Bureau of Plant Industry,
Office of the Chief,
Washington, D. C., August 18, 1911.

Sir: I have the honor to transmit herewith a paper entitled "Ice Houses," prepared by Prof. L. C. Corbett, Horticulturist of this Bureau, and recommend that it be published as a Farmers' Bulletin. It treats of the advantages of a supply of ice for farm use and gives directions for harvesting ice and constructing ice houses.

This paper has been prepared in response to numerous inquiries for information on the subject. It is believed that its publication will encourage producers to give more attention to the marketing of perishable products, as well as to provide their tables with home products which can not be kept without ice.

Very respectfully,

B. T. Galloway,
Chief of Bureau.

Hon. James Wilson,
Secretary of Agriculture.

CONTENTS.

	Page.
Introduction	5
The source of the ice supply	6
The principles of ice storage	6
The ice harvest	7
Clearing the ice field	7
Harvesting thin and thick ice	8
Floe ice	10
Ice manufactured in metal cans	11
Combination of natural and artificial means of obtaining ice	12
Types of ice houses and their advantages	12
Construction of ice houses	13
Inexpensive ice houses	13
Masonry ice houses	14
Relation of the ice supply to fruit storage	14
Combined ice house and dairy	16
Combined ice house and refrigeration plant for the storage of farm products	17
The construction of a refrigerator	18
The construction of an ice chest	19
Conclusion	20

ILLUSTRATIONS.

		Page.
FIG.	1. A horse-power scraper for removing snow from an ice field	7
	2. Diagram showing the insulation of an ice house for storing ice without sawdust or shavings	8
	3. An ice plow with a guide gauge	9
	4. An ice house equipped with a mechanical hoist for filling	10
	5. Superstructure of a pit for storing ice	11
	6. Diagrams showing cross sections of a building planned for storing ice above and fruit below	15
	7. Diagrams showing the wall construction and slat floor used in the building shown in figure 6	15
	8. Longitudinal section of a combined ice house and dairy	16
	9. Transverse section of a combined ice house and dairy	17
	10. Diagram showing a combined ice house and cold-storage plant	18
	11. Diagrams showing cross section and details of construction of a farm refrigerator	19

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ICE HOUSES.

INTRODUCTION.

The great variety of uses to which ice is now put in the economies of living is sufficient reason for a brief discussion of the principles of ice preservation and the construction of ice houses. In many parts of the country the harvesting of ice is an important industry. Immense houses are constructed and equipped with elaborate power devices for elevating ice. These houses are are only temporary storage quarters, however, as this great harvest of millions of tons is made to meet the wants of the sweltering cities during the heated months.

As the demand for ice in the cities increases with the rise in temperature, cars and ships are pressed into service to transport the contents of these great storehouses. Before the manufacture of artificial ice was a commercial possibility the storage and distribution of natural ice was the only means of relief for the denizens of the city from the summer heat. Downing in his essay on ice houses says that millions of dollars worth of ice has been shipped from Boston alone in the last eight years, a considerable part of this trade being with foreign countries. While at the present time most inland towns of the South rely upon the home manufacture of ice, coast cities still receive a part of their annual supply from the natural ice fields of the North, where it has been stored during the winter season.

It is not with the ice crop as a source of direct revenue that this bulletin treats, but with ice as a factor in the economies and comforts of the country home.

An ample supply of ice is of greater economic importance in the country home than in the city residence. City people can purchase perishable supplies as needed, but the remoteness of country homes from markets often renders it necessary to use canned, corned, or smoked meat products during the season of the year when the table should be supplied with fresh meats. Not only is ice appreciated because of its use in the preservation of fresh meats, butter, and other table supplies, but the production of high-grade domestic dairy products is almost impossible without it. Many markets to which

milk is now shipped demand that it be cooled before shipment to a degree not attainable without the use of ice.

Ice is one of those luxuries which in many sections of the country can be had for the gathering. The cost of harvesting and storing it is not great as compared with the comfort that it brings.

THE SOURCE OF THE ICE SUPPLY.

The source of the ice supply will vary with local conditions. In many sections lakes, rivers, or large streams will afford a supply of suitable ice without special plan or preparation on the part of man. In other instances, where such natural sources are not easily accessible, small streams or even the water from a spring can be stored in an excavation or by means of a dam, so as to afford sufficient water surface to provide the desired ice supply. The harvest area or surface will depend upon the tonnage to be stored and the normal thickness of the ice in the locality. In central New York the normal ice supply ranges from 8 to 12 inches in thickness, while in eastern Virginia 4 to 6 inches is as great a thickness as can usually be counted upon.

The stream or pond from which the supply of ice is taken should be fed from a source free from contamination or pollution. If the stream is so sluggish that water weeds thrive in it, all vegetation must be removed to prevent its freezing in the ice. Decaying vegetable matter frozen in ice is very objectionable, because as the ice melts this matter is deposited in the ice box or refrigerator, rendering it unnecessarily filthy and dangerous to health.

Ponds in which green spawn or algæ grow profusely can be rid of these pests by the use of copper sulphate. The crystals can be placed in a cloth sack, which is hung to a pole and trailed through the water until the salts are dissolved. One or two treatments of the sulphate during the season at the rate of 1 pound to 100,000 gallons of water will be sufficient to keep down such growth and make the water clear and pure. It is impossible to have pure ice unless the pond or stream is clean and the water is free from contamination.

THE PRINCIPLES OF ICE STORAGE.

In order to keep so perishable a commodity as ice it is necessary in the construction of a storage structure to consider carefully those physical and mechanical principles which underlie its preservation. (1) To keep well, ice must have a minimum of surface exposed to the air or to the packing material. This is most easily accomplished by piling the ice in the form of a cube. A mass of ice 12 by 12 by 12 feet exposes less surface than the same tonnage piled in any form less nearly that of a cube or of a globe. (2) The keeping

of good ice depends upon the completeness of its insulation, whereby it is protected from external influences, such as heat and air. (3) Drainage is important because the lack of it interferes with the insulation. (4) The ice itself must be packed so as to prevent as completely as possible the circulation of air through the mass. The more nearly the mass of ice approaches that of a solid cube, both in shape and texture, the easier, with good drainage and insulation, will be the keeping problem. The keeping of ice, then, depends upon the shape of the mass, its insulation, its drainage, and its solidity.

THE ICE HARVEST.

The ease and rapidity with which ice can be gathered depend upon the condition and location of the field and the character of the tools and conveniences at hand for doing the work.

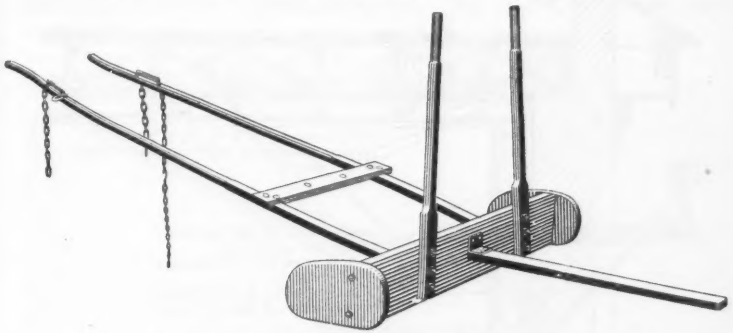

FIG. 1.—A horse-power scraper for removing snow from an ice field.

CLEARING THE ICE FIELD.

If the ice field is covered with snow the formation of ice will be retarded, as the snow acts as a blanket and raises the temperature, thus retarding the ice formation. If the ice sheet is sufficiently thick and snow falls upon it, the snow must be removed before harvesting can proceed; or if, on the other hand, it is desirable to increase the thickness of the ice after the snow falls, the field may be flooded and the snow saturated with water, which is allowed to freeze, thus adding a layer of snow ice. Flooding on small fields may be accomplished in either of two ways: (1) By "overflowing," which consists merely in conducting water to the field, or by piercing the ice field here and there with a bar or auger, to allow the water to force itself to the surface and gradually to saturate the snow.

Snow may be removed from small fields, when necessary, by means of shovels, but upon large fields it will be economical to use horse-power scrapers. A simple plank scraper is shown in figure 1.

HARVESTING THIN AND THICK ICE.

Ice not over 4 inches thick and ice from 6 to 15 inches in thickness require very different methods of procedure. The thin ice in general will be broken into more or less regular cakes, which will be loaded

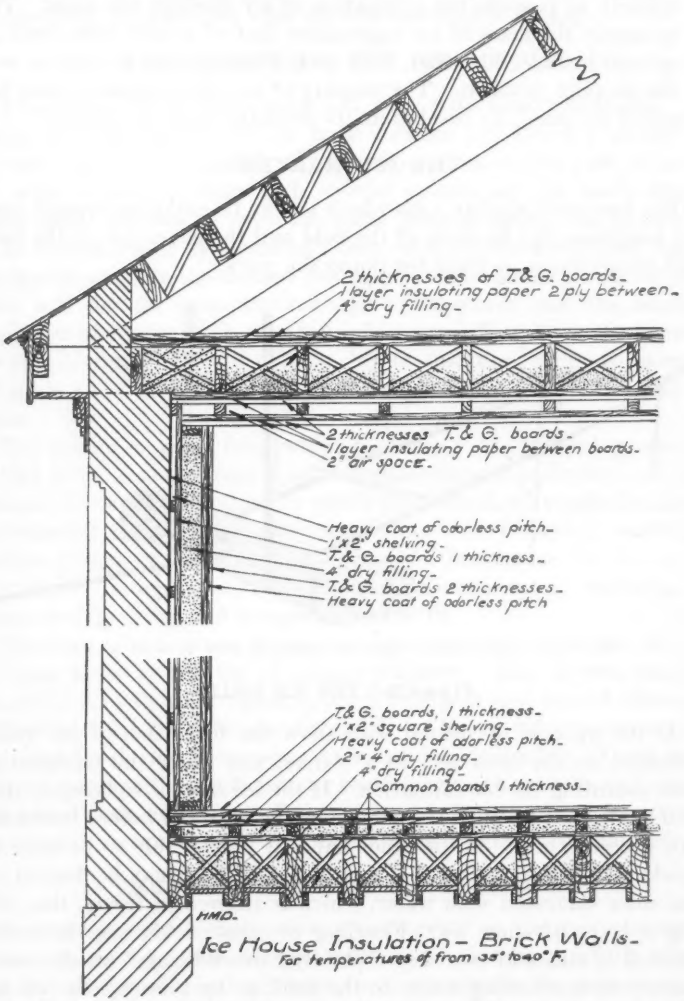
2 thicknesses of T. & G. boards.
1 layer insulating paper 2 ply between.
4" dry filling.
2 thicknesses T. & G. boards.
1 layer insulating paper between boards.
2" air space.
Heavy coat of odorless pitch.
1"x2" shelving.
T. & G. boards 1 thickness.
4" dry filling.
T. & G. boards 2 thicknesses.
Heavy coat of odorless pitch
T. & G. boards, 1 thickness.
1"x2" square shelving.
Heavy coat of odorless pitch.
2"x4" dry filling.
4" dry filling.
Common boards 1 thickness.
HMD.
Ice House Insulation – Brick Walls.
For temperatures of from 35° to 40° F.

FIG. 2.—Diagram showing the insulation of an ice house for storing ice without sawdust or shavings.

as best they may into sleds or wagons and hauled to the storehouse, where they may be arranged in layers and adjusted as closely as possible, the spaces between the cakes being filled with crushed ice or snow in such a manner as to cause the whole mass to freeze into

as nearly a solid block of ice as possible. It is more difficult to store and keep ice of this character than that harvested in regular cakes. Several factors combine to make the construction of a house for the preservation of such a supply more exacting than if built for keeping a better grade. Thin ice is characteristic of the southern limits of the storage of natural ice. The supply is more or less uncertain. The storage period is long. The irregular form of the cakes makes it difficult to pack the ice so as to prevent air spaces, which may form air passages and cause rapid loss. Irregular blocks and cakes are less easily insulated than regular cakes of uniform size and thickness. If the mass is stored in a building without packing material about it, insulation must be provided for in the construction of the house. The walls must be thick, well packed with mill shavings or dry sawdust, and tightly boarded on both sides of the packing material. A space of 15 inches between the walls, tightly packed with good insulating material, is none too much. An added safeguard would

FIG. 3.—An ice plow with a guide gauge.

be to double both the outside and inside walls. The type of wall construction suggested in figure 2 would be suitable for a house intended for the storage of ice of this character.

Harvesting ice from 6 to 15 or more inches in thickness permits the use of tools and implements that find no place in harvesting thin ice. The field may be laid off so as to cut the cakes to standard dimensions of 22 by 22 inches or 22 by 32 inches. Oblong cakes have some advantages over square ones, as they can be lapped so as to break joints as they are stored, thus reducing the possibility of the formation of air passages in the ice heap.

In order to obtain cakes square or rectangular in form a square made from light strips of boards with straight edges may be used. A square with sides 12 to 16 feet long will serve the purpose nicely. Draw a line across the ice field parallel with each side of the square and with a hand marker or with a saw accurately follow this line. By the use of a plow with a gauge attached, such as is shown in figure 3,

the field can be cut into parallel bands or ribbons. If the harvest is an extensive one and the water is of considerable depth, after the field is plowed at right angles to the first plowing the ice may be barred off in large masses or strips and floated to the shore or loading place, where it can easily be broken by an ice spud or bar into cakes of the dimensions outlined by the plow. The use of a plow is not confined to large fields or to ice that will bear the weight of a horse. In fact, ice fields on bodies of water too shallow to permit the use of a saw can be harvested by means of the plow by attaching to it a light wire cable or rope and operating it from the bank by horse power.

FIG. 4.—An ice house equipped with a mechanical hoist for filling.

On fields where ice is stored commercially the cakes are floated in large areas until near the channel, then barred off and carried by hoisting machines to the storage house, as suggested in figure 4. On small fields, where the quantity stored is 50 tons or less, the cakes are cut or barred off, floated to the loading platform, and placed upon it by hand or by horse power. The extent to which labor-saving devices may be introduced is measured by the cost of labor, the extent of the harvest, or the dispatch desired.

FLOE ICE.

Under certain conditions the only practicable way of obtaining a supply of natural ice is to catch it as it is going out in the spring. When the snow melts and the spring rains come on the ice at the headwaters of streams breaks up and is carried down in large masses,

which can be caught at considerable distances from the localities where it was formed. In this way ice can be obtained at small cost. In the early days many plantations along the Potomac harvested an annual supply of ice of this character and stored it for the most part in pits similar to that shown in figure 5. Those fortunate enough to live conveniently near large streams may often obtain their ice supply in this way.

ICE MANUFACTURED IN METAL CANS.

In some localities none of the sources of natural ice will be available. Under such conditions ice may be manufactured by using cans made of heavy galvanized iron and provided with a heavy band-iron or wire reenforcement around the top. Any tinsmith can make such cans. The cans should be of the dimensions of a standard cake of ice; that is, 22 inches square at the top, the bottom being somewhat smaller, so as to make the sides of the can slightly flaring. As soon as settled cold weather comes arrange the cans on a level plat of ground or on a level platform near the well or other water supply. Fill the cans with clear, fresh water, and when a sufficient thickness of ice has formed to permit them to be turned over, even if the shell of ice is not more than 1½ or 2 inches thick, pour a quart or two of boiling water over each upturned can to loosen it from the shell of ice. This will give a hollow shell of ice about 2 inches thick on the bottom, which was formerly the surface of the water in the can, 1½ inches thick on the sides, and with only a thin shell on the top, which was at the bottom of the can. Break the thin shell of ice over the top and remove all but about 2 inches of the water in the cavity. Place the shell of ice in an exposed but well-shaded situation, and as rapidly as the water in the shell freezes add a few quarts at a time until the entire cavity is filled and a solid block of ice is produced. In this way, with 15 to 25 cans the necessary supply for a farm can be secured at small cost in a few days, the time depending, of course, upon the weather conditions and the number

FIG. 5.—Superstructure of a pit for storing ice.

of cans in operation. If the cans are carefully handled they should last several years. The ice obtained in this way will be pure—free from vegetable growth, which sometimes damages pond and river ice. Because of its superior quality such ice will justify the construction of a building which will permit its being stored without the use of sawdust or shavings. A building constructed after the plan suggested in figure 2 will meet the requirements.

COMBINATION OF NATURAL AND ARTIFICIAL MEANS OF OBTAINING ICE.

The home ice supply is sometimes obtained by using a combination of natural and artificial means. Where an elevated water tank is at one's command, a line of pipe can be carried to perforated pipes placed on the ceiling of the ice house and during freezing weather the pressure from the tank can be used to carry water through the perforated pipes to be sprayed into the storage chamber as long as freezing continues. By careful use of this plan on cold nights and during freezing days a supply of ice can be built up in place. The protection of such a supply is the same as that of ice cut and stored in the usual manner.

TYPES OF ICE HOUSES AND THEIR ADVANTAGES.

Since ice at best is a highly perishable product, requiring special equipment for its preservation, such natural advantages as are offered by shade and exposure should be taken advantage of in locating an ice house. A shady situation with a northern exposure has a decided advantage as a location for such a building.

In general design ice houses are of three types: (1) Those built entirely above ground; (2) those built partly above and partly under ground; and (3) those of the cellar type, built entirely below ground. The aboveground structure is by far the most common of these types.

The advantages and disadvantages of these three types may be briefly stated as follows. Aboveground houses can, as a rule, be more economically constructed than either of the other designs. Excavations are expensive to make and difficult to insulate and drain properly. Insulation and drainage are two of the most important factors in the preservation of ice. It is true that the temperature of the earth varies less than that of the air, but the fact that the temperature of the earth at 6 or 8 feet below the surface remains at or about 55° F. the year around makes it quite as important to protect the stored ice against the earth heat as against the heated air. It is more difficult to remove ice as needed during the season from pits than from structures above ground. Slight advantages are apparent at harvest time in favor of the cellar or the half-sunken types of house, and under some circumstances they will be preferred to the other type.

CONSTRUCTION OF ICE HOUSES.

As has been explained, the length of time ice may be kept depends upon the character of insulation provided. This will naturally vary with the location of the ice house and the method of construction. Another important factor will be the cost of construction.

The simplest type of ice preservation consists in stacking the cakes in a compact mass on a well-drained site, as well protected as possible by natural or artificial barriers from sun and wind, and covering the mass with sawdust, shavings, fodder, marsh hay, or any other good insulating material. Such a crude method is not to be recommended except as a temporary makeshift for ice which is to be used early in the season.

INEXPENSIVE ICE HOUSES.

An inexpensive ice house which will give good satisfaction in localities on or north of the isotherm of New York City can be constructed as follows: As a site for the structure choose a well-sheltered location convenient to the place where the bulk of the ice will be used during the season. If the area is not well drained naturally, grade the surface so that no surface water can ever flow into or through the building and so that the water from the melting of the ice will be quickly disposed of. In some instances it may be necessary to provide tile drains laid 15 or 18 inches below the surface to care for this water.

Having properly provided against water, both from without and from within the ice house, set a line of squared or flattened poles 4 feet apart, so as to form a square of the dimensions desired. The height of the poles should be the same as the length of the side of the square, if the greatest economy of space and the best keeping conditions for the ice are desired, i. e., a building 14 feet square should be 14 feet high. A house of this size will provide storage for a cube of ice 11 by 11 by 11 feet, which, without allowance for voids, is equivalent to about 38 tons. (A cubic foot of ice weighs approximately 58 pounds, and 1 ton of ice occupies nearly 35 cubic feet.) To complete the ice house, cut the posts to a uniform height and nail a double 2 by 4 inch or 2 by 6 inch plate on top of them. The sides may be inclosed by boarding both inside and outside with rough lumber. To give a neat outside appearance the outside boards may be planed and ship-lapped, or ship-lap siding may be placed over the rough sheathing. The space between the two board walls may or may not be packed with shavings or sawdust. If packed, the packing material should be perfectly dry. The roof may be either a simple even-span one-third pitch roof, with the gables boarded up, or a hip roof.

In order that the house may be filled without unnecessary labor a continuous door should be provided in the middle of one end. The door should be made in two or three sections, and as the house is filled loose planks of proper length should be at hand to place across the opening of the door to hold the packing material in place as the heap of ice grows in height.

The ice must be placed on a bed of sawdust, shavings, or other packing material at least 15 inches deep, and the rick of ice should not approach the side walls closer than 15 or 18 inches, the intervening space being filled with packing material and thoroughly rammed.

MASONRY ICE HOUSES.

Instead of the cheap, temporary construction just described, ice houses of a permanent nature can be built from brick, stone, or concrete. In these, as in frame-constructed houses, the mass of ice should approach as closely as possible a cube in form. If the masonry house is to be used in the same manner as the temporary house no inside lining will be necessary. The packing used about the mass of ice may be allowed to come in direct contact with the wall. A 13-inch brick wall or a 12-inch concrete wall will provide the necessary strength. The masonry walls are not as good nonconductors as timber walls. It will therefore be necessary for the protection of the ice to rely on the packing material rather than on the wall itself. If the house is to be used for storing ice without the use of sawdust or shavings the construction indicated in figure 2 must be followed. The lining must be as complete on the floor and ceiling as on the side walls in order to provide safe insulation.

Masonry houses may be constructed entirely above ground or partly below the surface, as convenience or necessity may dictate.

RELATION OF THE ICE SUPPLY TO FRUIT STORAGE.

In order that fruits may be held for long periods in storage it is necessary that a uniform low temperature be maintained in the storeroom. With many products a uniform temperature is of more importance than a low temperature. With apples, which is the crop usually held in storage, it is desirable that the fruit reach an advanced state of maturity upon the tree, but that the ripening process be checked immediately when the fruit is placed in storage. This sudden check can not be effected in ordinary storage at picking time. It is therefore necessary that the storage house be provided with means for reducing the temperature to the required point and holding it there until natural conditions permit the introduction of cold air from the outside.

Several systems have been used for accomplishing this result. The simplest is to build the ice house as a two-story structure and to store

the ice above and the fruit below. The ice may be stored at harvest time in an ice house or in an ice chamber arranged over the room in

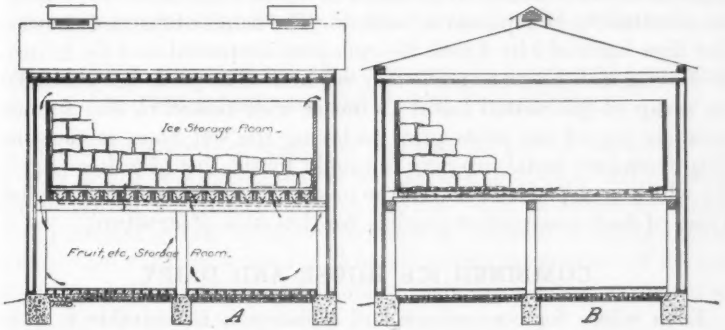

FIG. 6.—Diagrams showing cross sections of a building planned for storing ice above and fruit below: *A*, Longitudinal section; *B*, transverse section.

which the fruit is to be held, or the place may be simply a temporary storeroom to which the ice is transferred at the time the fruit is stored. Both these plans have been followed, but the one to be used in any particular instance will depend upon the cost of handling the ice and the certainty of the fruit harvest.

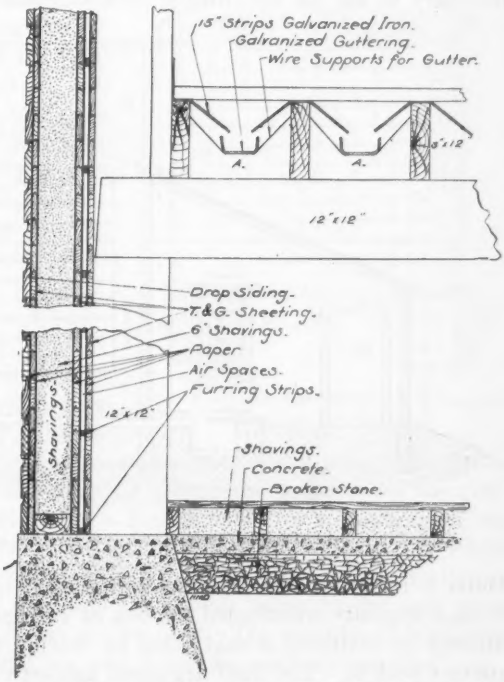

FIG. 7.—Diagrams showing the wall construction and slat floor used in the building shown in figure 6.

The general principles involved in the construction of such a house hold for both plans. Where the structure is for combined ice and fruit storage the ice chamber will of necessity be much larger than when ice is used merely to lower the temperature of the house at harvest time. The details of construction shown in figure 6

may be so modified as to adapt the building for either use. If the object is especially that of fruit storage, the ice chamber may be so reduced as to serve merely as a bunker in which to place several tons of ice at a time, to be replaced as needed. The detail of figure 7 shows a slat floor built of 2 by 4 inch Georgia pine supported on 2 by 12 inch or 3 by 12 inch joists, as needs may require. The joists are protected by a cap of galvanized metal 15 inches wide tacked to and formed over the top of the joists prior to laying the slat floor, so that the drip from each metal cap may be caught by the line of gutter (fig. 7, *A*) which is suspended between the joists. This is one of the simplest types of floor construction possible for this style of structure.

COMBINED ICE HOUSE AND DAIRY.

Even where for convenience and economy it is desirable to have the dairy under the same roof as the ice house, it is not satisfactory to attempt to combine the ice storage with a cold store. When it is necessary to use ice for chilling milk or other dairy products it is

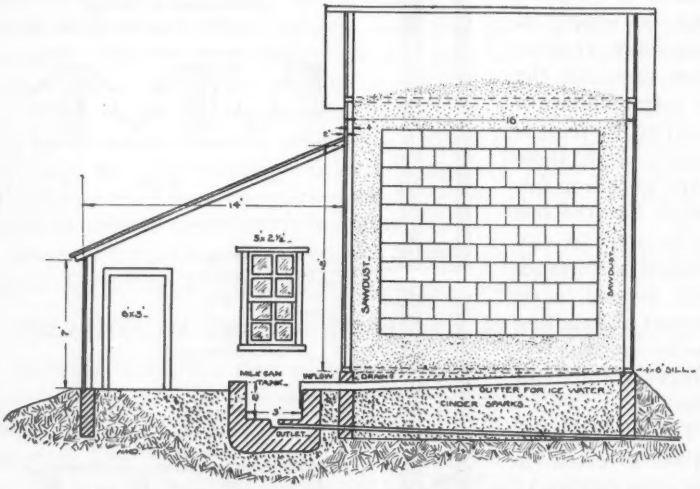

FIG. 8.—Longitudinal section of a combined ice house and dairy.

better to remove the ice from the ice house or compartment and place it in a specially constructed ice box or refrigerator rather than to attempt to maintain a cold room by storing the ice about and in contact with it. The chief argument against the combined arrangement is that it prevents the storage of ice in a solid mass. As a result the waste is much greater. Again, the requirements of the storage room and the refrigerator vary from time to time. Advantage can be taken of these fluctuation to husband the ice supply when

the two are separate. There are decided advantages in having the ice supply convenient to the dairy house or refrigerator, but it is poor economy to build the refrigerator or cold store inside the ice storage. The arrangement suggested in figures 8 and 9 is to be preferred.[1]

COMBINED ICE HOUSE AND REFRIGERATION PLANT FOR THE STORAGE OF FARM PRODUCTS.

Where an abundant supply of natural ice can be harvested annually it will be a simple matter to maintain high-class refrigeration by installing a brine circulating system. The principle on which this patented system works is the same as mechanical refrigeration, except that the cold is secured through a freezing mixture of ice and salt in a tank in which the primary coils are located, as shown at *B* in figure 10. As the brine in these coils becomes chilled it passes out through the bottom of the coils and slowly flows through the coils marked *C*, which are located in the cooling room. The heat of this room is absorbed by these chilled pipes and as the brine warms up it passes out and up into the primary coils, and in this way a continuous circulation is maintained between the two pipe systems.

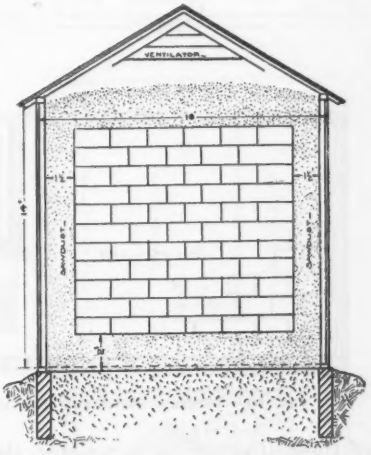

FIG. 9.—Transverse section of a combined ice house and dairy.

For convenience the ice house can be made a part of the structure, so that the ice can be elevated above the storage chamber and directly into the crusher, which can be located in the attic above the primary coils indicated at *B*. As the drawing shows, the space above the cooling room might be utilized as a farm shop or for a cooperage if one were to be installed in connection with an apple orchard. It would not be advisable to attempt to install this system without having an experienced engineer calculate the piping necessary for any given storage room as well as the cooling tank. The question of insulation is also a very important one and should be carefully specified.

[1] For more detailed information concerning the storage of butter, see Bulletin 84, and for the storage of cheese, see Bulletin 83, both of the Bureau of Animal Industry, United States Department of Agriculture.

This construction is adapted to small or to very extensive plants. The Department of Agriculture uses this system in a plant which has been installed at the Arlington Experimental Farm. The cooling room in this case is 28 by 30 feet with 8-foot ceilings. Sufficient space is thereby provided to store 800 barrels of apples.[1]

THE CONSTRUCTION OF A REFRIGERATOR.

The construction of a farm refrigerator large enough to meet the requirements of a well-equipped farm for the storage of eggs, butter, and fresh meat and for chilling or precooling fruits in small quantities is shown in figure 11. This refrigerator can be constructed in a cellar, in the lean-to of an ice house, or in any other farm building where convenient and suitable protection can be provided. If none

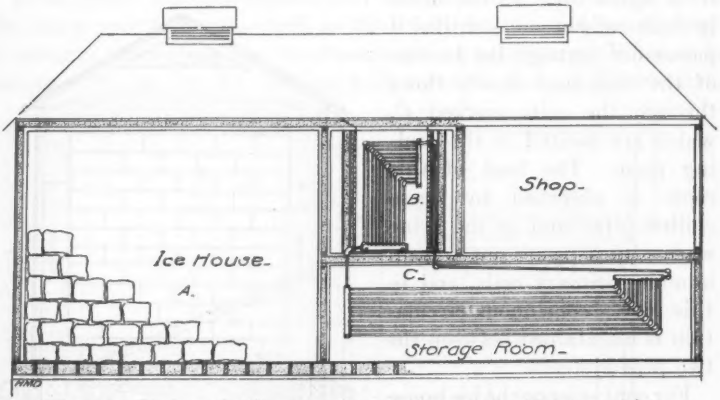

FIG. 10.—Diagram showing a combined ice house and cold-storage plant.

of these alternatives is possible, the refrigerator may be constructed as an independent building. If built as a separate structure, the same care in the choice of a site should be exercised as in choosing the location of an ice house. The construction is shown in detail in figure 11. The essential feature is a well-insulated room containing an ice rack, drip pan, and drain. This refrigerator is 8 by 10 feet and has a floor space 6 by 8 feet available for the storage of produce.

Such an arrangement will require about 100 tons of ice during the year, but it can be used to hold eggs and butter over the season of abundant production. A supply of fresh meat can be kept by such means in localities where distributing wagons are not run, and even where a local supply is available the producer can arrange to supply his table at wholesale rather than retail prices by killing his own

[1] For further information on the storing of apples, see Bulletin 48, Bureau of Plant Industry, United States Department of Agriculture.

sheep, pigs, or veal. Instances are known where an equipment of this sort has paid for itself in a single season through the advance secured by holding the egg output for only 60 days. Dealers purchase and store eggs while they are most abundant and cheapest and dispose of them during the season of less abundant production at an

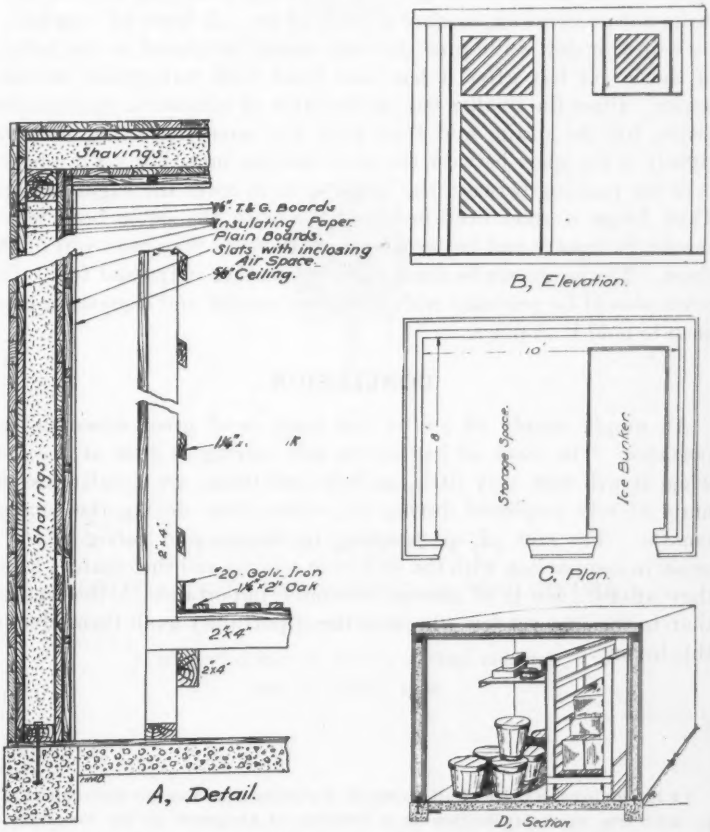

FIG. 11.—Diagrams showing cross section and details of construction of a farm refrigerator: *A*, Detail of wall construction and ice bunker; *B*, front elevation; *C*, floor plan; *D*, sectional view.

advanced price. A well-constructed and well-handled refrigerator of this kind on the farm will enable the producer to keep this profit at home.

THE CONSTRUCTION OF AN ICE CHEST.

Where a less expensive cooler is desired an ice chest will be found to serve a useful purpose. Such a chest can be made from two boxes,

one 12 inches longer and wider than the other and 6 inches deeper. If the inner box is 2 feet wide, 2 feet deep, and 3 feet long, the outer box should be 3 feet wide, 4 feet long, and 30 inches deep. The inner box, which should be made of matched white pine or cypress, should be lined with zinc and provided with a drip pipe in the bottom near one end and a metal grating 12 inches from that end, so as to make a cage in which to store a block of ice. A layer of 6 inches of cork dust or dry white-pine shavings should be placed in the bottom of the larger box after it has been lined with waterproof building paper. Place the smaller box on the layer of insulation, making provision for the drain, and then pack the same insulating material tightly in the space between the outer and the inner box. Fit a board over the packing between the boxes so as to cover the edges of both. Then hinge a thick well-insulated cover to the outer box, which should fit tightly and be large enough to cover the entire top of the chest. The joints can be made tight by weather strips and felt. The cover should be provided with a counter weight and a good ice-chest hasp to hold it in place.

CONCLUSION.

An ample supply of ice on the farm is of great economic importance. The work of harvesting and storing is done at a season when it will cost very little, as help and teams are usually less remuneratively employed during the winter than during the summer months. The cost of constructing ice houses and refrigerators is small in comparison with the economic returns and the comfort which they afford. Ice is of greater economic importance in the country than in the city, yet few who have the opportunity avail themselves of this luxury.

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475

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U. S. Department of Agriculture

ICE HOUSES

L. C. CORBETT
Horticulturist

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UNITED STATES DEPARTMENT OF AGRICULTURE

Contribution from the Bureau of Plant Industry
WM. A. TAYLOR, Chief

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OTHER features being satisfactory, a farm is well located that has a stream or lake or pond from which a supply of good, clear, clean ice may be harvested, and the farmer is doubly fortunate if there is an ice house at hand ready to receive it.

Aforetimes, the harvesting of natural ice was the only way to provide a supply for the needs of the coming summer, and even now that the production of artificial ice is a widespread industry there are many farms and towns remote from an ice factory which can be supplied cheaply only by storing natural ice.

These war times make heavy demands upon the fuel supply of the country, and, paradoxical as it may seem, it takes fuel to produce artificial ice, while natural ice may be harvested at a time when farm work is not pressing and both man and horse labor are not otherwise profitably employed. To save natural ice until needed in periods of high temperatures requires a storage place—in other words, an ice house—hence this bulletin contains instruction as to the building of proper structures, as well as methods of harvesting the ice.

B. P. I.—697.

ICE HOUSES.

CONTENTS.

	Page.		Page.
Economic importance	3	Combined ice house and dairy	14
The source of the ice supply	4	Combined ice house and refrigeration plant for the storage of farm products	15
The principles of ice storage	4	The construction of a refrigerator	16
The ice harvest	5	The construction of an ice chest	17
Types of ice houses and their advantages	10	Conclusion	18
Construction of ice houses	11		
Relation of the ice supply to fruit storage	12		

ECONOMIC IMPORTANCE.

THE great variety of uses to which ice is now put in the economies of living is sufficient reason for a brief discussion of the principles of ice preservation and the construction of ice houses. In many parts of the country the harvesting of ice is an important industry. Immense houses are constructed and equipped with elaborate power devices for elevating ice. These houses are only temporary storage quarters, however, as this great harvest of millions of tons is made to meet the wants of the sweltering cities during the heated months.

As the demand for ice in the cities increases with the rise in temperature, cars and ships are pressed into service to transport the contents of these great storehouses. Before the manufacture of artificial ice was a commercial possibility the storage and distribution of natural ice was the only means of relief for the denizens of the city from the summer heat. While at the present time most inland towns of the South rely upon the home manufacture of ice, coast cities still receive a part of their annual supply from the natural ice fields of the North, where it has been stored during the winter season.

An ample supply of ice is of greater economic importance in the country home than in the city residence. City people can purchase perishable supplies as needed, but the remoteness of country homes from markets often renders it necessary to use canned, corned, or smoked meat products during the season of the year when the table should be supplied with fresh meats. Not only is ice appreciated because of its use in the preservation of fresh meats, butter, and other table supplies, but the production of high-grade domestic dairy products is almost impossible without it. Many markets to which

milk is now shipped demand that it be cooled before shipment to a degree not attainable without the use of ice.

Ice is one of those luxuries which in many sections of the country can be had for the gathering. The cost of harvesting and storing it is not great as compared with the comfort that it brings.

THE SOURCE OF THE ICE SUPPLY.

The source of the ice supply will vary with local conditions. In many sections lakes, rivers, or large streams will afford a supply of suitable ice without special plan or preparation on the part of man. In other instances, where such natural sources are not easily accessible, small streams or even the water from a spring can be stored in an excavation or by means of a dam, so as to afford sufficient water surface to provide the desired ice supply. The harvest area or surface will depend upon the tonnage to be stored and the normal thickness of the ice in the locality. In central New York the normal ice supply ranges from 8 to 12 inches in thickness, while in eastern Virginia 4 to 6 inches is as great a thickness as can usually be counted upon.

The stream or pond from which the supply of ice is taken should be fed from a source free from contamination or pollution. If the stream is so sluggish that water weeds thrive in it, all vegetation must be removed to prevent its freezing in the ice. Decaying vegetable matter frozen in ice is very objectionable, because as the ice melts this matter is deposited in the ice box or refrigerator, rendering it unnecessarily filthy and dangerous to health.

Ponds in which green spawn or algæ grow profusely can be rid of these pests by the use of copper sulphate. The crystals can be placed in a cloth sack, which is hung to a pole and trailed through the water until the salts are dissolved. One or two treatments of the sulphate during the season at the rate of 1 pound to 100,000 gallons of water will be sufficient to keep down such growth and make the water clear and pure. It is impossible to have pure ice unless the pond or stream is clean and the water is free from contamination.

THE PRINCIPLES OF ICE STORAGE.

In order to keep so perishable a commodity as ice it is necessary in the construction of a storage structure to consider carefully those physical and mechanical principles which underlie its preservation. (1) To keep well, ice must have a minimum of surface exposed to the air or to the packing material. This is most easily accomplished by piling the ice in the form of a cube. A mass of ice 12 by 12 by 12 feet exposes less surface than the same tonnage piled in any form less nearly that of a cube or of a globe. (2) The keeping

of good ice depends upon the completeness of its insulation, whereby it is protected from external influences, such as heat and air. (3) Drainage is important because the lack of it interferes with the insulation. (4) The ice itself must be packed so as to prevent as completely as possible the circulation of air through the mass. The more nearly the mass of ice approaches that of a solid cube, both in shape and texture, the easier, with good drainage and insulation, will be the keeping problem. The keeping of ice, then, depends upon the shape of the mass, its insulation, its drainage, and its solidity.

THE ICE HARVEST.

The ease and rapidity with which ice can be gathered depend upon the condition and location of the field and the character of the tools and conveniences at hand for doing the work.

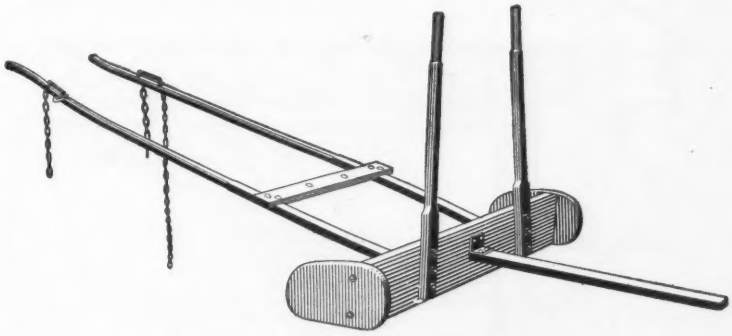

FIG. 1.—A horse-power scraper for removing snow from an ice field.

CLEARING THE ICE FIELD.

If the ice field is covered with snow the formation of ice will be retarded, as the snow acts as a blanket and raises the temperature, thus retarding the ice formation. If the ice sheet is sufficiently thick and snow falls upon it, the snow must be removed before harvesting can proceed; or if, on the other hand, it is desirable to increase the thickness of the ice after the snow falls, the field may be flooded and the snow saturated with water, which is allowed to freeze, thus adding a layer of snow ice. Flooding on small fields may be accomplished in either of two ways: (1) By "overflowing," which consists merely in conducting water to the field, or by piercing the ice field here and there with a bar or auger, to allow the water to force itself to the surface and gradually to saturate the snow.

Snow may be removed from small fields, when necessary, by means of shovels, but upon large fields it will be economical to use horse-power scrapers. A simple plank scraper is shown in figure 1.

HARVESTING THIN AND THICK ICE.

Ice not over 4 inches thick and ice from 6 to 15 inches in thickness require very different methods of procedure. The thin ice in general will be broken into more or less regular cakes, which will be loaded

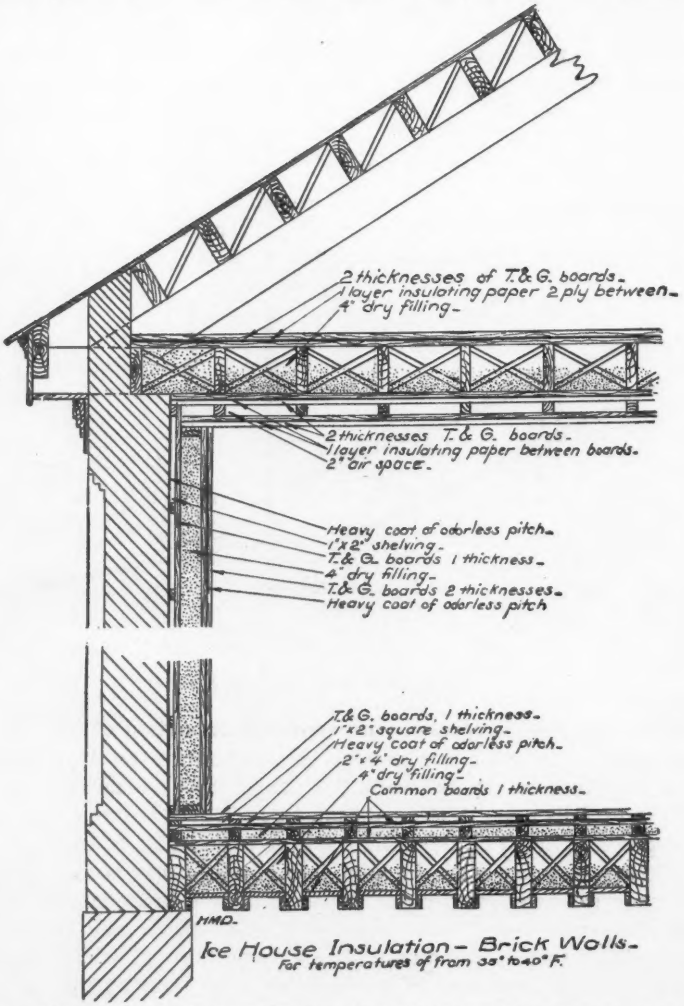
2 thicknesses of T. & G. boards.
1 layer insulating paper 2 ply between.
4" dry filling.
2 thicknesses T. & G. boards.
1 layer insulating paper between boards.
2" air space.
Heavy coat of odorless pitch.
1"x2" shelving.
T. & G. boards 1 thickness.
4" dry filling.
T. & G. boards 2 thicknesses.
Heavy coat of odorless pitch
T. & G. boards, 1 thickness.
1"x2" square shelving.
Heavy coat of odorless pitch.
2"x4" dry filling.
4" dry filling.
Common boards 1 thickness.
HMD.
Ice House Insulation - Brick Walls.
For temperatures of from 35° to 40° F.

FIG. 2.—Diagram showing the insulation of an ice house for storing ice without sawdust or shavings.

as best they may into sleds or wagons and hauled to the storehouse, where they may be arranged in layers and adjusted as closely as possible, the spaces between the cakes being filled with crushed ice or snow in such a manner as to cause the whole mass to freeze into

as nearly a solid block of ice as possible. It is more difficult to store and keep ice of this character than that harvested in regular cakes. Several factors combine to make the construction of a house for the preservation of such a supply more exacting than if built for keeping a better grade. Thin ice is characteristic of the southern limits of the storage of natural ice. The supply is more or less uncertain. The storage period is long. The irregular form of the cakes makes it difficult to pack the ice so as to prevent air spaces, which may form air passages and cause rapid loss. Irregular blocks and cakes are less easily insulated than regular cakes of uniform size and thickness. If the mass is stored in a building without packing material about it, insulation must be provided for in the construction of the house. The walls must be thick, well packed with mill shavings or dry sawdust, and tightly boarded on both sides of the packing material. A space of 15 inches between the walls, tightly packed with good insulating material, is none too much. An added safeguard would

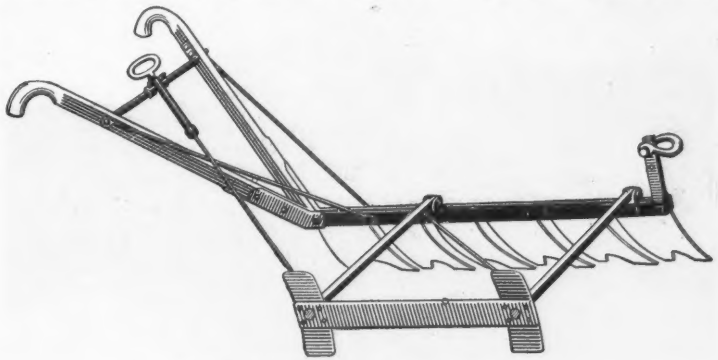

FIG. 3.—An ice plow with a guide gauge.

be to double both the outside and inside walls. The type of wall construction suggested in figure 2 would be suitable for a house intended for the storage of ice of this character.

Harvesting ice from 6 to 15 or more inches in thickness permits the use of tools and implements that find no place in harvesting thin ice. The field may be laid off so as to cut the cakes to standard dimensions of 22 by 22 inches or 22 by 32 inches. Oblong cakes have some advantages over square ones, as they can be lapped so as to break joints as they are stored, thus reducing the possibility of the formation of air passages in the ice heap.

In order to obtain cakes square or rectangular in form a square made from light strips of boards with straight edges may be used. A square with sides 12 to 16 feet long will serve the purpose nicely. Draw a line across the ice field parallel with each side of the square and with a hand marker or with a saw accurately follow this line. By the use of a plow with a gauge attached, such as is shown in figure 3,

the field can be cut into parallel bands or ribbons. If the harvest is an extensive one and the water is of considerable depth, after the field is plowed at right angles to the first plowing the ice may be barred off in large masses or strips and floated to the shore or loading place, where it can easily be broken by an ice spud or bar into cakes of the dimensions outlined by the plow. The use of a plow is not confined to large fields or to ice that will bear the weight of a horse. In fact, ice fields on bodies of water too shallow to permit the use of a saw can be harvested by means of the plow by attaching to it a light wire cable or rope and operating it from the bank by horse power.

FIG. 4.—An ice house equipped with a mechanical hoist for filling.

On fields where ice is stored commercially the cakes are floated in large areas until near the channel, then barred off and carried by hoisting machines to the storage house, as suggested in figure 4. On small fields, where the quantity stored is 50 tons or less, the cakes are cut or barred off, floated to the loading platform, and placed upon it by hand or by horse power. The extent to which labor-saving devices may be introduced is measured by the cost of labor, the extent of the harvest, or the dispatch desired.

FLOE ICE.

Under certain conditions the only practicable way of obtaining a supply of natural ice is to catch it as it is going out in the spring. When the snow melts and the spring rains come on the ice at the headwaters of streams breaks up and is carried down in large masses,

which can be caught at considerable distances from the localities where it was formed. In this way ice can be obtained at small cost. In the early days many plantations along the Potomac harvested an annual supply of ice of this character and stored it for the most part in pits similar to that shown in figure 5. Those fortunate enough to live conveniently near large streams may often obtain their ice supply in this way.

ICE MANUFACTURED IN METAL CANS.

In some localities none of the sources of natural ice will be available. Under such conditions ice may be manufactured by using cans made of heavy galvanized iron and provided with a heavy band-iron or wire reenforcement around the top. Any tinsmith can make such cans. The cans should be of the dimensions of a standard cake of ice; that is, 22 inches square at the top, the bottom being somewhat smaller, so as to make the sides of the can slightly flaring. As soon as settled cold weather comes arrange the cans on a level plat of ground or on a level platform near the well or other water supply. Fill the cans with clear, fresh water, and when a sufficient thickness of ice has formed to permit them to be turned over, even if the shell of ice is not more than 1½ or 2 inches thick, pour a quart or two of boiling water over each upturned can to loosen it from the shell of ice. This will give a hollow shell of ice about 2 inches thick on the bottom, which was formerly the surface of the water in the can, 1½ inches thick on the sides, and with only a thin shell on the top, which was at the bottom of the can. Break the thin shell of ice over the top and remove all but about 2 inches of the water in the cavity. Place the shell of ice in an exposed but well-shaded situation, and as rapidly as the water in the shell freezes add a few quarts at a time until the entire cavity is filled and a solid block of ice is produced. In this way, with 15 to 25 cans the necessary supply for a farm can be secured at small cost in a few days, the time depending, of course, upon the weather conditions and the number

FIG. 5.—Superstructure of a pit for storing ice.

of cans in operation. If the cans are carefully handled they should last several years. The ice obtained in this way will be pure—free from vegetable growth, which sometimes damages pond and river ice. Because of its superior quality such ice will justify the construction of a building which will permit its being stored without the use of sawdust or shavings. A building constructed after the plan suggested in figure 2 will meet the requirements.

COMBINATION OF NATURAL AND ARTIFICIAL MEANS OF OBTAINING ICE.

The home ice supply is sometimes obtained by using a combination of natural and artificial means. Where an elevated water tank is at one's command, a line of pipe can be carried to perforated pipes placed on the ceiling of the ice house and during freezing weather the pressure from the tank can be used to carry water through the perforated pipes to be sprayed into the storage chamber as long as freezing continues. By careful use of this plan on cold nights and during freezing days a supply of ice can be built up in place. The protection of such a supply is the same as that of ice cut and stored in the usual manner.

TYPES OF ICE HOUSES AND THEIR ADVANTAGES.

Since ice at best is a highly perishable product, requiring special equipment for its preservation, such natural advantages as are offered by shade and exposure should be taken advantage of in locating an ice house. A shady situation with a northern exposure has a decided advantage as a location for such a building.

In general design ice houses are of three types: (1) Those built entirely above ground; (2) those built partly above and partly under ground; and (3) those of the cellar type, built entirely below ground. The aboveground structure is by far the most common of these types.

The advantages and disadvantages of these three types may be briefly stated as follows. Aboveground houses can, as a rule, be more economically constructed than either of the other designs. Excavations are expensive to make and difficult to insulate and drain properly. Insulation and drainage are two of the most important factors in the preservation of ice. It is true that the temperature of the earth varies less than that of the air, but the fact that the temperature of the earth at 6 or 8 feet below the surface remains at or about 55° F. the year around makes it quite as important to protect the stored ice against the earth heat as against the heated air. It is more difficult to remove ice as needed during the season from pits than from structures above ground. Slight advantages are apparent at harvest time in favor of the cellar or the half-sunken types of house, and under some circumstances they will be preferred to the other type.

CONSTRUCTION OF ICE HOUSES.

As has been explained, the length of time ice may be kept depends upon the character of insulation provided. This will naturally vary with the location of the ice house and the method of construction. Another important factor will be the cost of construction.

The simplest type of ice preservation consists in stacking the cakes in a compact mass on a well-drained site, as well protected as possible by natural or artificial barriers from sun and wind, and covering the mass with sawdust, shavings, fodder, marsh hay, or any other good insulating material. Such a crude method is not to be recommended except as a temporary makeshift for ice which is to be used early in the season.

INEXPENSIVE ICE HOUSES.

An inexpensive ice house which will give good satisfaction in localities on or north of the isotherm of New York City can be constructed as follows: As a site for the structure choose a well-sheltered location convenient to the place where the bulk of the ice will be used during the season. If the area is not well drained naturally, grade the surface so that no surface water can ever flow into or through the building and so that the water from the melting of the ice will be quickly disposed of. In some instances it may be necessary to provide tile drains laid 15 or 18 inches below the surface to care for this water.

Having properly provided against water, both from without and from within the ice house, set a line of squared or flattened poles 4 feet apart, so as to form a square of the dimensions desired. The height of the poles should be the same as the length of the side of the square, if the greatest economy of space and the best keeping conditions for the ice are desired, i. e., a building 14 feet square should be 14 feet high. A house of this size will provide storage for a cube of ice 11 by 11 by 11 feet, which, without allowance for voids, is equivalent to about 38 tons. (A cubic foot of ice weighs approximately 58 pounds, and 1 ton of ice occupies nearly 35 cubic feet.) To complete the ice house, cut the posts to a uniform height and nail a double 2 by 4 inch or 2 by 6 inch plate on top of them. The sides may be inclosed by boarding both inside and outside with rough lumber. To give a neat outside appearance the outside boards may be planed and ship-lapped, or ship-lap siding may be placed over the rough sheathing. The space between the two board walls may or may not be packed with shavings or sawdust. If packed, the packing material should be perfectly dry. The roof may be either a simple even-span one-third pitch roof, with the gables boarded up, or a hip roof.

In order that the house may be filled without unnecessary labor a continuous door should be provided in the middle of one end. The door should be made in two or three sections, and as the house is filled loose planks of proper length should be at hand to place across the opening of the door to hold the packing material in place as the heap of ice grows in height.

The ice must be placed on a bed of sawdust, shavings, or other packing material at least 15 inches deep, and the rick of ice should not approach the side walls closer than 15 or 18 inches, the intervening space being filled with packing material and thoroughly rammed.

MASONRY ICE HOUSES.

Instead of the cheap, temporary construction just described, ice houses of a permanent nature can be built from brick, stone, or concrete. In these, as in frame-constructed houses, the mass of ice should approach as closely as possible a cube in form. If the masonry house is to be used in the same manner as the temporary house no inside lining will be necessary. The packing used about the mass of ice may be allowed to come in direct contact with the wall. A 13-inch brick wall or a 12-inch concrete wall will provide the necessary strength. The masonry walls are not as good nonconductors as timber walls. It will therefore be necessary for the protection of the ice to rely on the packing material rather than on the wall itself. If the house is to be used for storing ice without the use of sawdust or shavings the construction indicated in figure 2 must be followed. The lining must be as complete on the floor and ceiling as on the side walls in order to provide safe insulation.

Masonry houses may be constructed entirely above ground or partly below the surface, as convenience or necessity may dictate.

RELATION OF THE ICE SUPPLY TO FRUIT STORAGE.

In order that fruits may be held for long periods in storage it is necessary that a uniform low temperature be maintained in the storeroom. With many products a uniform temperature is of more importance than a low temperature. With apples, which is the crop usually held in storage, it is desirable that the fruit reach an advanced state of maturity upon the tree, but that the ripening process be checked immediately when the fruit is placed in storage. This sudden check can not be effected in ordinary storage at picking time. It is therefore necessary that the storage house be provided with means for reducing the temperature to the required point and holding it there until natural conditions permit the introduction of cold air from the outside.

Several systems have been used for accomplishing this result. The simplest is to build the ice house as a two-story structure and to store

the ice above and the fruit below. The ice may be stored at harvest time in an ice house or in an ice chamber arranged over the room in

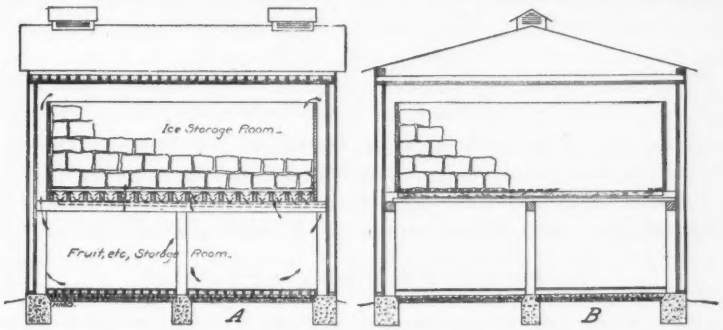

FIG. 6.—Diagrams showing cross sections of a building planned for storing ice above and fruit below: *A*, Longitudinal section; *B*, transverse section.

which the fruit is to be held, or the place may be simply a temporary storeroom to which the ice is transferred at the time the fruit is stored. Both these plans have been followed, but the one to be used in any particular instance will depend upon the cost of handling the ice and the certainty of the fruit harvest.

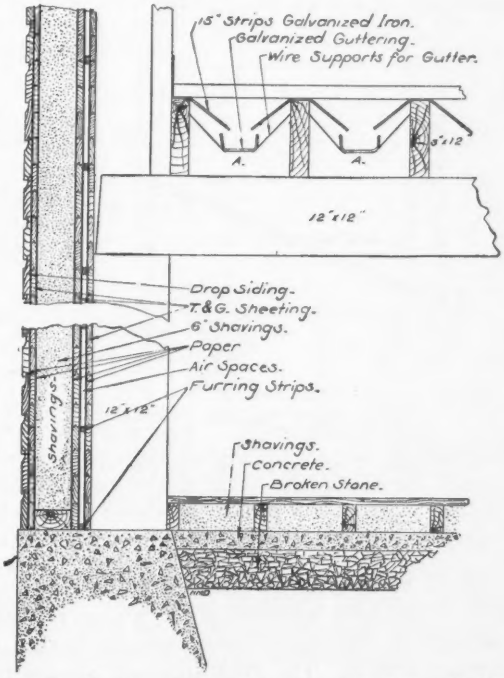

FIG. 7.—Diagrams showing the wall construction and slat floor used in the building shown in figure 6.

The general principles involved in the construction of such a house hold for both plans. Where the structure is for combined ice and fruit storage the ice chamber will of necessity be much larger than when ice is used merely to lower the temperature of the house at harvest time. The details of construction shown in figure 6

may be so modified as to adapt the building for either use. If the object is especially that of fruit storage, the ice chamber may be so reduced as to serve merely as a bunker in which to place several tons of ice at a time, to be replaced as needed. The detail of figure 7 shows a slat floor built of 2 by 4 inch Georgia pine supported on 2 by 12 inch or 3 by 12 inch joists, as needs may require. The joists are protected by a cap of galvanized metal 15 inches wide tacked to and formed over the top of the joists prior to laying the slat floor, so that the drip from each metal cap may be caught by the line of gutter (fig. 7, *A*) which is suspended between the joists. This is one of the simplest types of floor construction possible for this style of structure.

COMBINED ICE HOUSE AND DAIRY.

Even where for convenience and economy it is desirable to have the dairy under the same roof as the ice house, it is not satisfactory to attempt to combine the ice storage with a cold store. When it is necessary to use ice for chilling milk or other dairy products it is

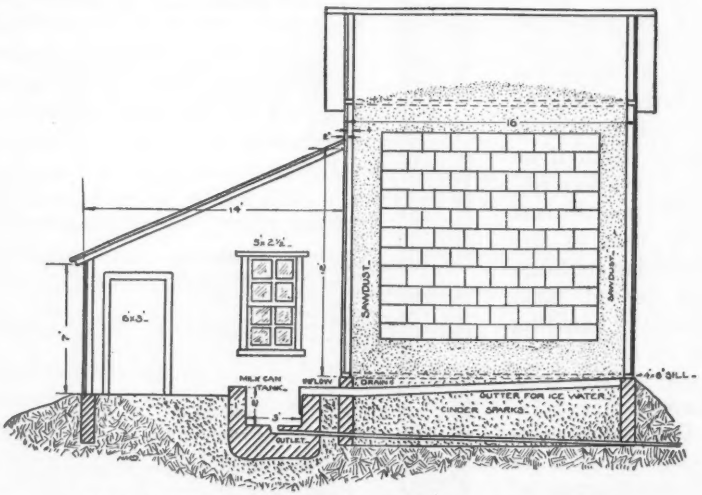

FIG. 8.—Longitudinal section of a combined ice house and dairy.

better to remove the ice from the ice house or compartment and place it in a specially constructed ice box or refrigerator rather than to attempt to maintain a cold room by storing the ice about and in contact with it. The chief argument against the combined arrangement is that it prevents the storage of ice in a solid mass. As a result the waste is much greater. Again, the requirements of the storage room and the refrigerator vary from time to time. Advantage can be taken of these fluctuation to husband the ice supply when

the two are separate. There are decided advantages in having the ice supply convenient to the dairy house or refrigerator, but it is poor economy to build the refrigerator or cold store inside the ice storage. The arrangement suggested in figures 8 and 9 is to be preferred.[1]

COMBINED ICE HOUSE AND REFRIGERATION PLANT FOR THE STORAGE OF FARM PRODUCTS.

Where an abundant supply of natural ice can be harvested annually it will be a simple matter to maintain high-class refrigeration by installing a brine circulating system. The principle on which this patented system works is the same as mechanical refrigeration, except that the cold is secured through a freezing mixture of ice and salt in a tank in which the primary coils are located, as shown at *B* in figure 10. As the brine in these coils becomes chilled it passes out through the bottom of the coils and slowly flows through the coils marked *C*, which are located in the cooling room. The heat of this room is absorbed by these chilled pipes and as the brine warms up it passes out and up into the primary coils, and in this way a continuous circulation is maintained between the two pipe systems.

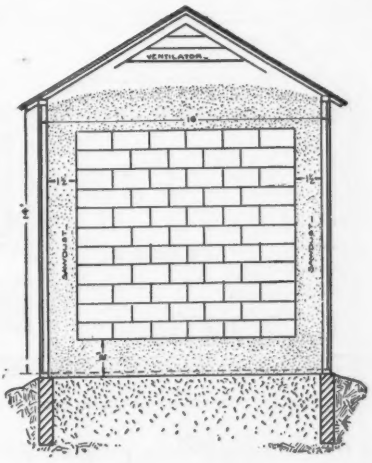

FIG. 9.—Transverse section of a combined ice house and dairy.

For convenience the ice house can be made a part of the structure, so that the ice can be elevated above the storage chamber and directly into the crusher, which can be located in the attic above the primary coils indicated at *B*. As the drawing shows, the space above the cooling room might be utilized as a farm shop or for a cooperage if one were to be installed in connection with an apple orchard. It would not be advisable to attempt to install this system without having an experienced engineer calculate the piping necessary for any given storage room as well as the cooling tank. The question of insulation is also a very important one and should be carefully specified.

[1] For more detailed information concerning the storage of butter, see Bulletin 84, and for the storage of cheese, see Bulletin 83, both of the Bureau of Animal Industry, United States Department of Agriculture.

This construction is adapted to small or to very extensive plants. The Department of Agriculture uses this system in a plant which has been installed at the Arlington Experimental Farm. The cooling room in this case is 28 by 30 feet with 8-foot ceilings. Sufficient space is thereby provided to store 800 barrels of apples.[1]

THE CONSTRUCTION OF A REFRIGERATOR.

The construction of a farm refrigerator large enough to meet the requirements of a well-equipped farm for the storage of eggs, butter, and fresh meat and for chilling or precooling fruits in small quantities is shown in figure 11. This refrigerator can be constructed in a cellar, in the lean-to of an ice house, or in any other farm building where convenient and suitable protection can be provided. If none

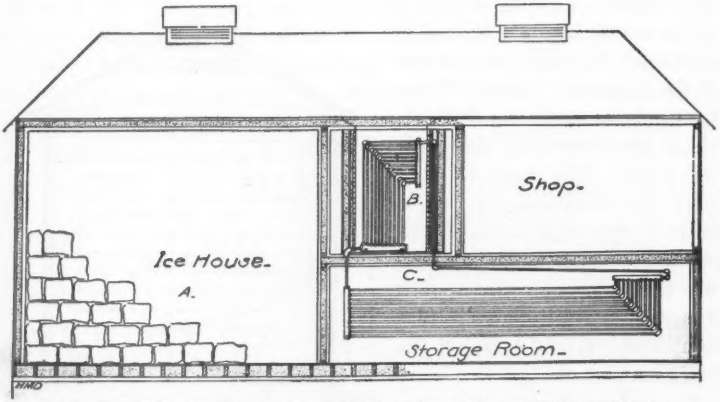

FIG. 10.—Diagram showing a combined ice house and cold-storage plant.

of these alternatives is possible, the refrigerator may be constructed as an independent building. If built as a separate structure, the same care in the choice of a site should be exercised as in choosing the location of an ice house. The construction is shown in detail in figure 11. The essential feature is a well-insulated room containing an ice rack, drip pan, and drain. This refrigerator is 8 by 10 feet and has a floor space 6 by 8 feet available for the storage of produce.

Such an arrangement will require about 100 tons of ice during the year, but it can be used to hold eggs and butter over the season of abundant production. A supply of fresh meat can be kept by such means in localities where distributing wagons are not run, and even where a local supply is available the producer can arrange to supply his table at wholesale rather than retail prices by killing his own

[1] For further information on the storing of apples, see Bulletin 48, Bureau of Plant Industry, United States Department of Agriculture.

sheep, pigs, or veal. Instances are known where an equipment of this sort has paid for itself in a single season through the advance secured by holding the egg output for only 60 days. Dealers purchase and store eggs while they are most abundant and cheapest and dispose of them during the season of less abundant production at an

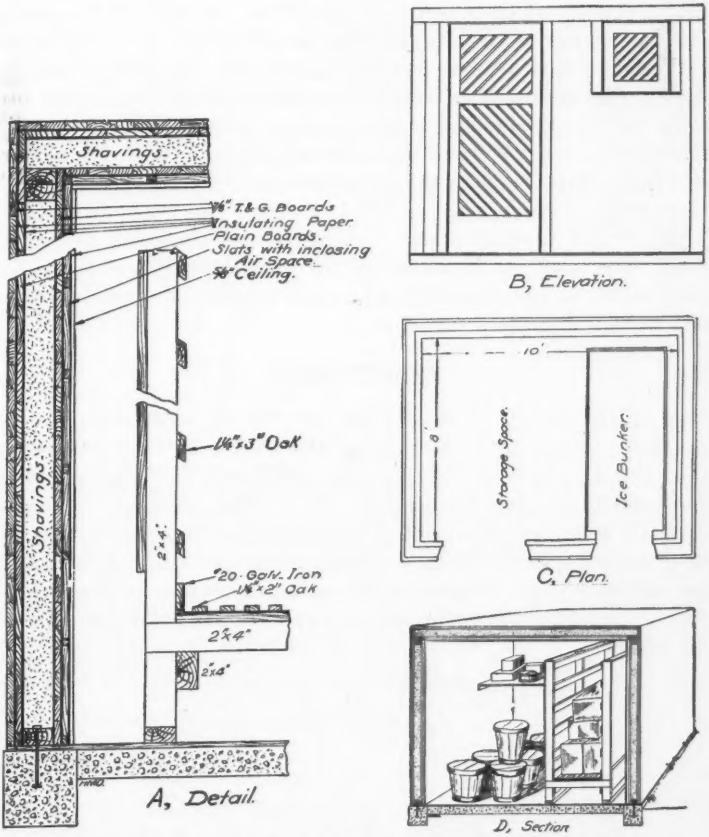

FIG. 11.—Diagrams showing cross section and details of construction of a farm refrigerator: *A*, Detail of wall construction and ice bunker; *B*, front elevation; *C*, floor plan; *D*, sectional view.

advanced price. A well-constructed and well-handled refrigerator of this kind on the farm will enable the producer to keep this profit at home.

THE CONSTRUCTION OF AN ICE CHEST.

Where a less expensive cooler is desired an ice chest will be found to serve a useful purpose. Such a chest can be made from two boxes,

one 12 inches longer and wider than the other and 6 inches deeper. If the inner box is 2 feet wide, 2 feet deep, and 3 feet long, the outer box should be 3 feet wide, 4 feet long, and 30 inches deep. The inner box, which should be made of matched white pine or cypress, should be lined with zinc and provided with a drip pipe in the bottom near one end and a metal grating 12 inches from that end, so as to make a cage in which to store a block of ice. A layer of 6 inches of cork dust or dry white-pine shavings should be placed in the bottom of the larger box after it has been lined with waterproof building paper. Place the smaller box on the layer of insulation, making provision for the drain, and then pack the same insulating material tightly in the space between the outer and the inner box. Fit a board over the packing between the boxes so as to cover the edges of both. Then hinge a thick well-insulated cover to the outer box, which should fit tightly and be large enough to cover the entire top of the chest. The joints can be made tight by weather strips and felt. The cover should be provided with a counter weight and a good ice-chest hasp to hold it in place.

CONCLUSION.

An ample supply of ice on the farm is of great economic importance. The work of harvesting and storing is done at a season when it will cost very little, as help and teams are usually less remuneratively employed during the winter than during the summer months. The cost of constructing ice houses and refrigerators is small in comparison with the economic returns and the comfort which they afford. Ice is of greater economic importance in the country than in the city, yet few who have the opportunity avail themselves of this luxury.

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INDEX.

	Farmers' Bulletin No.	Page.
Accounts, dairy business, importance of system	469	11, 14
Agriculture Department, cooperation in work against chestnut bark disease	467	22–23
Secretary, report on investigation of prices of transporting and delivering city milk	469	16
value of grosbeaks, etc	456	1–14
Agrilus bilineatus, factor in spread of chestnut bark disease	467	10
Agropyron repens. *See* Quack grass.		
Alabama, game laws, 1911	470	9, 16, 31, 37, 40, 46
spring lambs, raising, experiments	457	17–18, 20
Alaska, game laws, 1911	470	9, 16, 31, 37, 40, 46
Alberta, game laws, 1911	470	27, 34, 39, 42, 51
Alfalfa, growing on potato farm, management	454	14
	472	27–30
rotation systems, New Jersey	472	27–30
rotations, comparison with other rotations, profits, etc	472	28–29
Alsike clover, description, value, etc	455	36
	462	13
See also Clover, alsike.		
Amber sorghum, value as forage in northern sections	458	8–10
sorghums, characteristics	458	7
varieties, description, value, etc	458	10
Ammonia, availability of nitrogen compared with other forms	465	5, 6
Angora goat, pasturing on logged-off land, advantages	462	17–18
Animal feeding experiments	457	18–20
	466	17–18
	469	8, 9–10
Animals, breeding, danger in feeding root crops	465	16
Antelope, protection in Arizona	470	4
Anthracnose, cucumbers in frames, preventive measures	460	26–27
red clover, damage, etc	455	40–41
Aphids, danger to frame crops, control measures	460	27
Aphis punk, use on frame crops	460	27
Apricot scale, food of grosbeaks, note	456	9
Arkansas, game laws, 1911	470	16, 31, 37, 40, 46
Arkell, T. R., experiments in feeding turnips to sheep	469	8
Army camps, danger of typhoid epidemics from house flies	459	9
Ashes, wood, value for marsh land	465	9
truck growing	460	14
Asparagus, fertilizing, suggestions	469	7–8
growing, suggestions	469	7–8
Atwood, Horace, directions for construction of brick silo, cost, etc	457	23–24
Bacillus tuberculosis, discovery by Dr. Koch	473	5
Bacteria, nitrogen-fixing, functions, description, etc	451	8–9
Bag limits, game, in United States and Canada	470	40–42
Baits for cutworms in frame crops	460	27
Bang, Professor, of Denmark, system for suppression of bovine tuberculosis	473	20–22
Bark borers, factor in spread of chestnut bark disease	467	10
disease, chestnut. *See* Chestnut bark disease.		
Bean, velvet. *See* Velvet bean.		

	Farmers' Bulletin No.	Page.
Beans, snap, growing under frames, management	460	25
packing for market	460	29
Beattie, W. R., bulletin on "Frames as factor in truck growing"	460	1–29
Beavers, J. C., and George A. Billings, bulletin on "Systems of farming in central New Jersey"	472	1–40
Bedding, hogs, suggestions	465	19
milch cows, recommendations	457	21
Beef-measle tapeworm, spread from excreta	463	12
Beets, garden, growing in frames, varieties, management, etc	460	24–25
sugar, feeding to breeding stock, danger	465	16
Belgium, nursery conditions	453	13
Bennett, R. T., experiment in growing winter emmer in North Carolina	466	13
Bermuda grass, value for lawns, management, etc	469	5, 6
Bill bugs, food of grosbeaks, note	456	9
Billings, George A., and J. C. Beavers, bulletin on "Systems of farming in central New Jersey"	472	1–40
Birds, nongame, legislation affecting	470	9
Black-headed grosbeak, habitat, food habits, etc	456	9–10
"Bladder stones" in live stock, danger from feeding root crops	465	16
"Blast," sorghum, cause	458	11
Bloating, live stock, treatment	455	24–25
Blossoms, tree, study in primary grades	468	11
Blowfly, description	459	6
Blue grosbeak, habitat, food habits, etc	456	11–12
pop, habitat, food habits, etc	456	11–12
Bluebottle flies, description	459	6
small, description	459	6
Bluegrass, Kentucky, value for lawns, management, etc	469	5, 6
pasture on logged-off land, management, etc	462	12
Boll weevil, control by clean farming methods	457	11–14
food of grosbeaks, note	456	9, 12
Bordeaux mixture, use for control of cucumber diseases	460	26–27
Bran, wheat, feed for sheep, experiment	457	20
Breakfast food, value of emmer	466	17
Breeding animals, feeding root crops, danger	465	16
Brewster, C. E., Henry Oldys, and Frank L. Earnshaw, bulletin on "Game laws for 1911"	470	1–52
British Columbia, game laws, 1911	470	14, 27, 34, 39, 42, 52
Broadleaf trees, key	468	40–43
Brooding turkeys artificially, experiments	465	23
Brooks, Ethan, method for tarring seed corn	456	12
W. P., statements on clover growing, and on curing clover hay	451	7–10
Brown-tail moth. *See* Moth.		
rash, moth-infested regions, note	453	11
Bruchophagus funebris, description, damage, etc	455	38
Buckhorn, occurrence in red clover, note	455	41
Buffum, B. C., experiments in growing emmer in Wyoming	466	13–16
Buildings, ice houses	475	1–20
Bull clover. *See* Clover, Mammoth.		
Burge, Sidney, experiments with vetch as winter-cover crop	472	15–16
Bur-grass seed, destruction by grosbeaks, note	456	12
Burning over logged-off land, management	462	9–10
Burritt, M. C., bulletin on "A successful New York farm"	454	1–32
Butter fat, percentage in milk	469	13
making, propagation of starters	469	17–18
Calcimine, damp-proof, composition, etc	474	21
Calcimines, composition, covering capacity, etc	474	21
Calendar, forest, suggestions for making	468	32–33
California, emmer-growing experiments	466	12
game laws, 1911	470	9, 16, 31, 41, 46

	Farmers Bulletin No.	Page.
Calliphora erythrocephala, description	459	6
Calves, feeding, value of emmer	466	17
from dairy cows, value for veal and for breeding	469	12
tuberculous cows, management	473	21
Canada, game laws in different Provinces	470	14, 15, 27–29, 34–35, 39–40, 42, 51–52
Cane, Japanese, growing for forage, value, etc	457	8–11
production of sirup	457	8
system, training grapevines	471	28
Cankerworms, food of grosbeaks, note	456	9, 10, 12
Capon, description and characteristics	452	5–6
Caponizing and capons, history, management, etc	452	1–16
Capons and caponizing, history, management, etc	452	1–16
feeding	452	13
killing and dressing for market	452	13–14
profits in rearing	452	14–16
Cardinals, habitat, food habits, etc	456	9
CARLETON, MARK ALFRED, bulletin on "Winter emmer"	466	1–24
Carrots, wild, occurrence in red clover, note	455	41
CATES, J. S., bulletin on "The eradication of quack grass"	464	1–11
Cattle, cough, symptom of tuberculosis	473	10
feeding, value of emmer	466	17–18
Florida, forage supply, etc	457	8
grazing on logged-off pasture land, advantages	462	18–19
infection by tuberculosis, means	473	17
tuberculosis, prevalence, spread, suppression, etc	473	1–23
tuberculous, post-mortem appearances	473	11–12
See also Cows; Dairy cattle.		
Caywood system, overhead training for grapevines	471	24
Cement, Portland, nature, management, etc	461	5–6
Centipede, house, enemy to house fly	459	15
Chalcis fly, clover-seed, description, damage, etc	455	38
Chamberlain, J. S., statement on digestible nutrients in oats, emmer, and einkorn	466	20–21
Cheese making, propagation of starters	469	17–18
Cherry scale, food of grosbeaks, note	456	9
trees, protection from birds	456	13
wild, use as protection of orchards from birds	456	13
Chestnut bark disease, control	467	1–24
measures near Washington, D. C	467	10–11
history, distribution, cause, symptoms, and spread	467	5–10
necessity for popular knowledge	467	22
protection of Southern States, importance	467	23
specimens from Department of Agriculture	467	22–23
blight disease in Pennsylvania, commission for control, appointment, personnel, etc	467	15, 17
borer, two-lined, factor in spread of chestnut-bark disease	467	10
nursery stock, inspection of diseased	467	17–18
orchardists, suggestions	467	20
trees, in cities, losses from chestnut-bark disease	467	5–6
ornamental, advice to owners	467	21–22
sprouts caused by bark disease	467	9
treatment for bark disease	467	18–20
Chickens, breeds for caponizing, selection	452	6
caponizing, management, etc	452	7–13
See also Capons.		
Chittenden system, training grapevines	471	24
Cholera, Asiatic, infection from house flies	459	9
hog, transmission by dogs and buzzards, note	465	18
infection from house fly, note	459	8
Cicada, periodical, food of grosbeaks, note	456	9
Clinton, Dr., method for sterilizing tobacco beds	451	6–7
Close, C. P., suggestions for fertilizing asparagus	469	7–8

	Farmers' Bulletin No.	Page.
Clover, alsike, danger in continued use	455	36
description, value, etc	455	36
	462	13
value for pasture on logged-off land	462	13
and alfalfa mixtures, seeding, etc	454	14
crimson, use as winter-cover crop in potato growing	472	10
value, danger in feeding, etc	455	36
in truck growing	460	14
Giant White, comparison with red clover	455	36
growing, conditions essential	451	7–9
New York potato farm	454	14–15
with timothy on potato farm, cultural methods	472	22–24
hay, curing	451	9–10
cutting time	451	9
Japan, description, value as forage crop, etc	455	37
Ladino, comparison with red clover, etc	455	36
leaf spot, description, note	455	40
Mammoth, advantages, varietal names, etc	455	34–35
value on farms without live stock	455	29
Mexican, description, value as forage crop, etc	455	37
place in rotation on potato farm	454	7, 12
	472	9
rotations, restoration, etc	455	44–46
red, adaptability to soils and climates	455	8
advantages over other varieties	455	34
comparison with other species	455	35–37
composition and digestibility compared with other forage plants	455	25–26
danger as pasture	455	24–25
description and analysis of plant	455	7, 23
effect on land	455	26–27
fertilizers suitable	455	12–13
fungous diseases	455	40–41
growing, value, etc	455	1–48
history, distribution, etc	455	5–6
in mixtures	455	26
rotations	455	27–30
insect enemies	455	37–39
production in different sections of the United States	455	46–47
requirements for obtaining a stand	455	9–21
seed production, management	455	30–34
value as silage and soiling crops	455	24
for lawns and for pasture, management, etc	455	24–25
	462	13
	469	5, 6
varieties	455	34–35
root-borer, description, damage, etc	455	37–38
seed, pasturing	455	31
sweet, description, value as forage crop, etc	455	37
white, comparison with red clover	455	35
value for pasture on logged-off land	462	13–14
yields on potato farm	454	15
See also varietal names.		
Clover-flower midge, description, damage, etc	455	38–39
Clover-hay worm, description, damage, etc	455	39
Clover-leaf weevil, description, damage, etc	455	39
Clovers, Russian red, description	455	35
Clover-seed chalcis fly, description, damage, etc	455	38
Clover-sickness, causes, nature, etc	455	41–44
Cluster fly, description	459	5
Codling moth, food of grosbeaks, note	456	9
College students, summer work on chestnut bark disease, note	467	12, 13
Colletotrichum trifolii, damage to red clover, remedies, etc	455	40–41
COLLINS, J. FRANKLIN, and HAVEN METCALF, bulletin on "The control of the chestnut bark disease"	467	1–24

	Farmers' Bulletin No.	Page.
Colorado, game laws, 1911	470	10, 17, 31, 37, 41, 46
Concrete board, construction	461	13
equipment and tools for mixing	461	12–14
forms, plans, lumber for making, etc	461	21–23
manufacture, directions	461	9–18
materials for making, selection, quantities, etc	461	5–9, 11–12
mixing method	461	15–18
placing, method	461	18–21
two-bag batch, materials and resulting amount, tables	461	10, 12
use on the farm	461	1–23
Coniferous trees, key	468	39–40
Connecticut, game laws, 1911	470	10, 17, 31, 37, 46
CONNER, A. B., bulletin on "The best two sweet sorghums for forage"	458	1–23
CORBETT, L. C., bulletin on "Ice houses"	475	1–20
Corn, cultural methods	472	14, 16–18
feed for sheep, results of experiment	457	19–20
for silage, growing in New Jersey	472	28
nurse crop for red clover, management	455	17–18
place in rotation in potato growing districts	472	9
rotation with red clover, management	455	27–28, 29
seed, treatment to prevent destruction by grosbeaks	456	12
seed-bed preparation	472	14
Corn-ear worm, food of grosbeaks, note	456	9
Cory, V. L., report on growing emmer	466	11
Cotton, early maturity, use of fertilizers	457	14–15
growing in boll weevil district, experiment by department	457	13
rotation with red clover	455	30
stalks, destruction in boll weevil districts, importance, methods, etc	457	12–14
worm, food of grosbeaks, note	456	9, 12
Cottonseed meal, feed for sheep	457	18
toxic properties, caution, etc	457	18
Cotton-stalk cutter, V-shaped, construction and cost	465	11–15
Cover crop, value of velvet bean, note	451	10
crops, potato growing	472	9–11, 15–16, 17
Cow, dairy, cost of care, etc	469	12–14
individuality, factor in economic milk production	465	20–22
Cowpeas, rotation with red clover, management	455	29
value, comparison with velvet beans	451	12
in truck growing	460	14
Cows, dairy, testing, officially, importance	465	21–23
value, estimates by milk production	469	11
good *v.* poor, as investment, estimate	469	11–16
in milk, increase of feed, note	457	18–19
lumps in udder, symptom of tuberculosis	473	11
milch, bedding	457	21
relation of food consumption to milk production	465	20–22
Crab-grass, occurrence in red clover	455	41
Crimson clover, use as winter cover crop in potato growing	472	10
value, caution, etc	455	36
See also Clover.		
Crop Pest Commission, Louisiana State, control of boll weevil	457	12
rotation, four-crop system, management of potato farm	472	30–38
New Jersey, different systems	472	8–30
York farm	454	7–8, 12
rotations, potato farms, suggestions	454	7–8, 12 8–30,
	472	37–38
with red clover	455	27–30, 44–46
wheat and potatoes	472	24–25
Cropping systems, central New Jersey	472	7–30

	Farmers' Bulletin No.	Page
Crops, damage by grosbeaks, preventive measures	456	12–13
drought-resistant, value of emmer	466	9
field, value of winter emmer	466	16
management in frames	460	19–25
Cross-wire overhead system, training grapevines	471	24–25
Cucumber beetles, food of grosbeaks, note	456	8, 9
Cucumbers in frames, diseases affecting, preventive measures	460	26–27
management, etc	460	21–23
packing for market	460	28–29
Cultivator, potato, description	454	17
Curing clover hay	451	9–10
sorghum hay	458	19–20
Cuttings, grape, heeling in	471	6
planting	471	12
selection, and management	471	6
Cutworm, cotton, food of grosbeaks, note	456	9, 12
Cutworms, control in frame crops, methods	460	27
Dairy accounts, improvement of system, importance	469	11, 14
cattle, Denmark, improvement method	469	12
combined with ice house, plans	475	11–17
cows. *See* Cows.		
herd, financial returns of good and poor, estimates	469	10–16
industry, New Jersey, remarks	472	26–27
Dairyman, system of keeping accounts, importance	469	11, 14
Davis, A. L., experiment in growing emmer in California	466	13
Delaware, game laws, 1911	470	10, 17, 31, 37, 41, 46
Delwiche, E. J., statement on storage of root crops	465	15–16
Dasyneura leguminicola, description, damage, etc	455	38–39
Dew itch, cause	463	11
sores, cause	463	11
Diaporthe parasitica, cause of chestnut-bark disease	467	6–10
Diarrhea, Cochin-China, spread from excreta	463	10, 11
infantile, transmission by house flies, note	459	9
spread by soil pollution	463	10
Diplosis sorghicola, description, damage to sorghum seed crop, etc	458	11
Dipping vats for hogs, construction	465	19
Dips, destruction of hog parasites, preparation, use, etc	465	19–20
Diseases, bacterial, spread from excreta	463	8–10
human, spread from soil pollution	463	8–12
intestinal, infection from house fly	459	8, 9, 10
parasitic, spread from excreta	463	10–12
transmission by house flies	459	8, 9, 10
District of Columbia, game laws, 1911	470	17, 41
infested nursery stock, danger, control, etc	453	8–9
Dodder, occurrence in red clover, damage, eradication, etc	455	41
Doe laws, Vermont and Washington, note	470	4
Dougherty, M. S., and W. Newell, description of cotton-stalk cutter	465	11–15
Drainage, marsh soils, management	465	7
New York potato farm	454	9–12
"Drop," disease of lettuce under frames, cause, preventive measures, etc	460	25–26
Drosophila ampelophila, note	459	7, 10
Dry farming, value of emmer	466	8–9, 16
Dunlap, A. L., experiment in growing emmer in Michigan	466	13
Dysentery, amoebic, spread from excreta	463	11
spread by soil pollution	463	10
transmission by house flies, note	459	9
Earnshaw, Frank L., Henry Oldys, and C. E. Brewster, bulletin, on "Game laws for 1911"	470	1–52
Education, forestry in nature study	468	5–43
Eelworm infection, cause	463	11
Eggplant, growing in frames, management	460	23–24
Eggplants, packing for market	460	29

	Farmers' Bulletin No.	Page.
Einkorn, digestible nutrients	466	21
Elder, use as protection of fruit from birds	456	13
Elk, preservation in Wyoming, State legislation	470	9
Emmer, analyses	466	19–20
black winter, introduction into United States	466	9
characteristics	466	5–6
comparison with other grain feed crops	466	17–18, 21
digestible nutrients	466	21
feeding value compared with other grains	466	17–18, 21
growing experiments, etc	466	8–16
in high altitudes, note	466	8
North Dakota, yields for eight years compared with other grains	466	19
origin, distribution, etc	466	7–8
production in Russia	466	7
resistance to smuts and rusts	466	11, 22
value as feed compared with other grain feeds	466	13, 17–18, 21
varieties, description, characteristics, etc	466	23
winter, characteristics, value, etc	466	1–24
cultivation	466	21–22
introduction into United States	466	9
uses	466	17–18, 22
value as field crop	466	16
yield compared with other small grains	466	11, 19
Emmers, production of compound heads	466	23
Empusa muscæ, fungous disease of house fly	459	15
England, nursery conditions	453	14
Ensilage, red clover, management	455	24
Erysiphe polygoni, description	455	40
Etheridge, W. C., report on scuppernong growing in North Carolina	457	15–16
Euproctis chrysorrhœa. *See* Moth, brown-tail.		
Europe, nursery conditions	453	12–14
Evergreens, study in schools, outline of work, and key	468	18–19, 39–40
Ewe, mountain, value in spring lamb production	457	17
Ewes in milk, increase of feed, note	457	19
scrub, value basis of flock, experiments in Alabama	457	17–18, 20
southern, value in rearing spring lambs, cost, etc	457	17
Excrement, human, breeding place for flies, danger, etc	463	12
Excreta, danger as breeding place for typhoid fly	459	9, 12
	463	8–10
human, carriers of diseases	463	8–12
proper disposal, importance, methods, etc	463	7–32
Experiment Station work, LXIII	451	1–24
LXIV	456	1–24
LXV	465	1–24
LXVI	469	1–24
Factory whitewash, recipe	474	20
Fan system, training for grapevines	471	20
Farm land, Oregon, demand, etc	462	6–8
Washington, demand, etc	462	6–8
management, New Jersey	472	30–39
York	454	1–32
tenant, management in New Jersey	472	30–38
use of concrete	461	1–23
paint	474	1–22
Farming, New Jersey, influence of experiment station	472	8
successful, measure	454	22–24
systems in Central New Jersey	472	1–40
Farms, American, privy conditions	463	13
dry, use of weeder harrow	465	9–11
potato, equipment in tools, etc	454	28–31
	472	34–35
management	454	1–32
	472	30–38

	Farmers' Bulletin No.	Page.
Farrell, F. D., statement on growing emmer at Nephi, Utah	466	12
Fattening lambs	457	19
	466	17
	469	9
Federal game legislation 1911	470	9
Feed, dry regions, value of emmer	466	16
emmer, preference by stock, note	466	13
root crops for breeding animals, danger	465	16
sweet sorghum, value, etc	458	20
value of emmer	466	11, 16
red clover	455	25–26
winter, production on logged-off land	462	17
Feeding dairy cows, cost	469	13–14
lambs for market, danger, management, etc	469	9–10
sheep, experiments	457	18–20
	466	17–18
	469	8–10
sorghum hay	458	20
turkeys	465	23–24
Fertilizer, home-mixed, for potatoes	454	17
mixtures. *See* Fertilizers.		
use in cucumber growing, composition, etc	460	22
value of velvet bean compared with other fertilizers	451	11–12
See also Manure.		
Fertilizers, commercial, cost of nitrogen content to farmer, remarks	465	6
different grades, relative composition	457	5–7
for alfalfa	472	29–30
asparagus	469	7–8
corn	472	14–16
cotton, to hasten maturity	457	14–15
lawns in South	469	5, 6
potatoes on different soils	454	17
	472	18–19
red clover	455	12
timothy and clover mixture	472	23–24
truck crops grown under frames, management	460	14–15
low-grade, expensiveness	457	5–7
use in potato growing	472	14
on marsh lands	465	8–9
Field trips, forestry study in schools, suggestions	468	29–31
Figart, S. A., experiment in growing emmer in Kansas	466	13
Figeater, southern, food of grosbeaks, note	456	9
Flea beetles, locust, food of grosbeaks, note	456	9
Flies, breeding in human excrement, danger, etc	463	12
carriers of diseases	459	9
	463	9, 10
house. *See* House flies.		
See also varietal names.		
Flooding ice fields, management	475	7
Florida, forage conditions, value of Japanese cane, etc	457	8
game laws, 1911	470	10, 18, 31, 37, 41, 46
velvet bean as crop, value, etc	451	12
Flower beetles, destruction by grosbeaks, note	456	9, 10
Flowers, growing on New York potato farm	454	28
Flytraps, use in destruction of house flies, suggestions	459	14
Foal, joint disease, etc	451	23–24
navel disease, etc	451	23
rearing by hand, management	451	22–23
Foals, newborn, care, etc	451	21–24
Food, breakfast, value of emmer	466	17
Forage, Japanese cane, storage	457	9
plants, composition and digestibility of different kinds	455	25–26
sorghum, management for heavy yields	458	14–17
sweet sorghums, best two	458	1–23

	Farmers' Bulletin No.	Page.
Forage, value of Japan clover or lespedeza	455	37
Japanese cane	457	8–11
Forest calendar, suggestions for making	468	32–33
enemies, study in schools, outline of work	468	23–24
industries, study in schools, outline of work	468	24–25
influences, study in schools, outline of work	468	22–23
museum, collection and use, suggestions	468	33–36
products, commercial, collection of specimens for forest museum	468	35–36
trees, fruits, and nuts, study in primary grades	468	11–13
reproduction, study in schools, outline of work	468	21–22
Forestry books, supplementary list for schools	468	37–38
differentiation from "Tree study"	468	5–7
experiments for school work	468	25–29
in common schools, methods of teaching	468	7–8
nature study	468	1–43
schools, outlines for a course of study	468	9–25
Forests, care and management, study in schools, outline of work	468	25
United States, study in schools, outline of work	468	24–25
Formaldehyde, use in sterilizing tobacco beds	451	6–7
Formalin, use in sterilizing tobacco beds	451	6–7
Four-cane Kniffin-system training for grapevines	471	21–22
Foxtail, occurrence in red clover, note	455	41
seed, destruction by grosbeaks, note	456	12
Frames as a factor in truck growing	460	1–29
cloth-covered, for truck growing, description, construction, cost, etc	460	10–11
for truck growing, types, construction, etc	460	10–13
glass-covered, protective methods	460	19
heated, for truck growing, description, construction, cost, etc	460	13
sash-covered, description, construction, cost, etc	460	11–13
truck-growing, ventilation, temperature, etc	460	17–19
France, north, exports of nursery stock to United States, nature, value, etc	453	12
nursery conditions, and shipments to United States	453	6, 12, 13
Francis, D. F., experiments in seeding logged-off land	462	16
Fraser, W. J., estimates of cost of market milk	469	11–14
Frosted scale, food of grosbeaks, note	456	9
Frosts, killing, in central New Jersey, 1901–1910	472	6
Fruit growers. *See* Orchardists.		
lecanium, European, food of grosbeaks	456	9
protection from birds	456	13
storage, relation of ice supply	475	14–16
trees, wild, decoys for birds	456	13
fly, note	459	7, 10
Fruits, forest trees, study in primary grades	468	11–13
small, growing, importance, etc., New York potato farm	454	26–27
Fungous diseases of red clover	455	40–41
plants, remedy	451	5
Game, bag limits, restrictions in several States	470	6–7
United States and Canada	470	40–42
big, protection in South Dakota, note	470	4–5
export and sale, modification of regulations in several States	470	6
regulations, United States and Canada	470	29–35, 46–52
funds from sale of licenses, utilization in several States	470	4
hunting and shipping licenses, United States and Canada	470	29–35, 43–52
increase measures in several States	470	4
laws for 1911	470	1–52
legislation, retrograde	470	5
licenses, modifications of regulations in several States	470	7
open seasons in United States and Canada	470	15–29
modifications in several States	470	5–6
preserves, legislation in several States	470	8
State, establishment in United States and Canada	470	4

	Farmers' Bulletin No.	Page.
Game, propagation, legislation in several States	470	8
sale, laws governing, United States and Canada	470	36–40
shipment, laws governing in United States and Canada	470	29–36
warden service, results of legislation in several States	470	7–8
Garden, importance on farm	454	25–27
New York potato farm, management, etc	454	25–27
Gardening, study in schools, outline of work	468	19–21
Georgia, game laws, 1911	470	18, 31, 41, 46
Giant white clover, comparison with red clover, etc	455	36
Gipsy moth, effect on property value	453	11
See also Moth.		
Goat, Angora, pasturing on logged-off land, advantages	462	17–18
Gooseneck sorghum, description	458	7–8
Grafting, bench, methods, directions, etc	471	7, 8, 9–10
English cleft method	471	9–10
grape, advantages	471	8
care of scions	471	8
methods	471	7–10
prevention of water sprouts	471	8
vineyard, directions	471	8, 10
whip method	471	9–10
Grain, protection from grosbeaks	456	12–13
spring-seeded, rotations with red clover	455	28
Grainfields, damage by grosbeaks, note	456	11
Grape cuttings, care and planting	471	6, 12
propagation, pruning, and training	471	1–29
regions of United States	471	28–29
Grapes, scuppernong, growing in North Carolina	457	15–16
varieties grown east of Rocky Mountains	471	29
west of Rocky Mountains	471	28–29
Grapevine, parts, description and functions	471	10–12
Grapevines, care and training	471	12–28
planting, management	471	12–13
training systems, directions	471	17–28
Grass, orchard. *See* Orchard grass.		
Grasses, pasture mixtures for logged-off land	462	14–16
root-stock varieties of Genus *Agropyron*, eradication	464	5–11
varieties for lawns in South	469	5
Grasshoppers, destruction by grosbeaks	456	12
Gray grosbeak, habitat, food habits, etc	456	12
Grazing cattle on logged-off pasture land	462	18–19
Green-manure crops. *See* Manure, green.		
Grosbeaks and their value to agriculture	456	1–14
damage to crops, preventive measures	456	12–13
different kinds, descriptions, food habits, etc	456	7–12
protection, management	456	13–14
Ground itch, cause	463	11
Gurler silo, construction, value, etc	469	19–24
Guthrie, E. S., directions for propagation of starters for butter and cheese making	469	17–18
Gypsum, application to red clover crop	455	13
Harrow, weeder, use on dry farm	465	9–11
Harrowing potato land, method	454	15–16
Harrows, use in preparation of corn seed-bed	472	14
Harvesting alfalfa, method in New Jersey	472	30
clover hay on potato farm	454	15
corn	472	17–18
ice, management	475	7–11
Japanese cane for forage	457	11
potatoes, methods	454	19
	472	21–22
red clover seed crop	455	32–33
sorghum hay	458	13, 19–20
wheat, New York potato farm	454	13

	Farmers' Bulletin No.	Page.
Haskins, H. D., examination of fertilizers in Massachusetts, results, etc	457	6
Hatching turkeys artificially	465	22–23
Hay, alfalfa, making	472	30
alsike clover, value, danger, etc	455	36
brown clover, making	455	23
caps, value in curing hay	451	9
clover, curing	451	9–10
value as feed, comparison with timothy hay	451	9
crimson clover, danger in feeding	455	36
harvesting	451	9, 14
	454	15
	455	23
	458	14, 19
	472	30
leaves, red clover, value, curing, etc	455	22–23
mixtures, seeding	454	14
	472	23
red clover, management	455	21–25
salting, remedy for clover-hay worm	455	39
sorghum, harvesting and curing	458	13–14, 19–20
marketing	458	21
spontaneous combustion, cause	455	23
stacking, management of red clover	455	23
velvet bean, cutting, curing, etc	451	14
danger in feeding, etc	451	14
worm, description, damage, etc	455	39
Health, effect of brown-tail moth	453	11–12
Heaters, orchard, use to ward off frost	460	19
Herd's grass, value for lawns in South	469	5
High-renewal training for grapevines	471	18–19
HILLMAN, F. H., and J. M. WESTGATE, bulletin on "Red clover"	455	1–48
Hog diseases, treatment	465	19–20
Hogenson, J. C., description of weeder harrow for dry farms	465	10–11
Hogs, bedding, suggestions	465	19
changing pasture, importance	465	18
Florida, forage supply, etc	457	8
intestinal worms, cause	465	18
mange, treatment	465	19–20
new purchases, quarantine measures	465	18
raising in New Jersey, purpose	472	8
sanitary care in the South	465	17–20
tuberculosis, prevalence	473	7
Holland, nursery conditions	453	12
shipment of nursery stock to auctioneer in Washington, D. C	453	8
Homalomyia brevis, note	459	6, 9
canicularis, description	459	6–7
Honey sorghum, description	458	8
Hookworm description, life history and effects	463	11
disease, spread by excreta	463	10, 11
Horizontal block training for grapevines	471	19
Horses, care of mare and foal	451	20–24
draft, quality and conformation	451	15–19
House flies, breeding places	459	7–9
	463	12
danger to human health	459	7–8
destruction, methods	459	10–16
life history, danger, remedies, etc	459	1–16
natural enemies	459	15
remedies and preventives	459	10–14
fly, small, description	459	6
Houses, hog, portable, directions for construction	465	18–20
HOWARD, L. O., bulletin on "House flies"	459	1–16
summary of importations of infested nursery stock, 1909–1911	453	5–8

	Farmers' Bulletin No.	Page.
Hudson horizontal training for grapevines	471	21
HUNTER, BYRON, and HARRY THOMPSON, bulletin on "Utilization of logged-off land for pasture in western Oregon and western Washington"	462	1–20
Hunting licenses, United States and Canada	470	43–52
open seasons for game, United States and Canada	470	15–29
restriction of methods in several States	470	9
HUSMANN, GEORGE C., bulletin on "Grape propagation, pruning, and training"	471	1–29
Hylastinus obscurus, description, damage, etc	455	37–38
Hyponomeuta padella found on imported nursery stock	453	6, 7
Hypsopygia costalis, description, damage, etc	455	39
Ice chest, construction, directions	475	19–20
fields, clearing of snow	475	7
floe, value for storage	175	10–11
harvest, clearing the field	474	7
house with dairy, plans	475	16–17
houses, plans, construction, etc	475	1–20
types, advantages of each	475	12
manufacture in metal cans	475	11–12
plow, description	475	9
storage, principles	475	6–7
supply, relation to fruit storage	475	14–16
source, sanitary condition, etc	475	6
Idaho, game laws, 1911	470	10, 18, 31, 37, 41, 46
Illinois, game laws, 1911	470	10, 18, 31, 37, 41, 46
Implements, outfit necessary for treatment of chestnut-bark disease	467	18
Importations, nursery stock, danger	453	1–22
Incubation, artificial, in turkey raising	456	22–23
Indiana, game laws, 1911	470	10, 18, 31, 37, 41, 46
Infant diseases, transmission by flies	459	9
Insects affecting truck crops under frames, control measures	460	27
food of grosbeaks, notes	456	7–8, 9, 10, 11, 12
pollinizing, relation to production of red clover seed	455	34
Inspection, chestnut nursery stock	467	17–18
imported nursery stock, efforts in District of Columbia	453	9
nature	453	9–10
Intermountain districts, value of emmer	466	16
Iowa, game laws, 1911	470	10, 19, 31, 37, 41, 47
Irrigated sections, value of red clover	455	8
Irrigation, truck crops, sprinkler system	460	16
under frames, management	460	16–17
Italian rye-grass, value for pasture on logged-off land	462	12
Itch, varieties caused by hookworm	463	11
JACKSON, EDWIN R., bulletin on "Forestry in nature study"	468	1–43
Japan clover, description, value as forage crop, etc	455	37
Japanese cane. *See* Cane.		
Joint disease, foals, cause and treatment	451	23–24
Juneberry, use as protection of orchards from birds	456	13
Kansas, emmer-growing experiments	466	11
game laws, 1911	470	10–11, 19, 31, 37, 41, 47
Kentucky, bluegrass. *See* Bluegrass.		
game laws, 1911	470	19, 31, 37, 41, 47
Kerosene emulsion, use on frame crops	460	27
value for destruction of house-fly larvæ in manure	459	12

	Farmers' Bulletin No.	Page.
"Kidney stones" in live stock, danger from feeding root crops	465	16
Kinney, Carl S., experiments in destruction of quack-grass	464	11
Kniffin, William, system for training grapevines	471	21–22
Koch, Robert, discovery of tuberculosis germ	473	5
Labor, New York potato farm	454	22
requirement per acre on New Jersey potato farm	472	34
Lacto, new frozen dairy product, recipes, etc	457	21–23
Ladino clover, comparison with red clover	455	36
Lamb industry, Batavia, N. Y., management	469	9–10
spring, demand	457	17
Lambs, disease from overfeeding, description, fatality, etc	469	9–10
early spring raising in South	457	16–20
fattening, use of emmer *v.* barley	466	17
feeding, cost and profits in use of different feeds	466	18
overfeeding, cause of losses at Batavia, N. Y	469	9–10
winter-fed, losses in New York, investigations, etc	469	9–10
See also, Sheep.		
Land, logged-off, utilization for pasture in western Washington and western Oregon	462	1–20
See also, Logged-off land.		
wet, pasture mixtures, amount of seed to acre, etc	462	14
value of alsike clover	462	13
Lawns, permanent in the South, making	469	5–6
shaded, value of mixture of blue grass and Bermuda grass	469	5
Laws, game, for 1911	470	1–52
Layering, grape propagation, directions	471	6–7
Leaf studies, primary grades, outline of work	468	10
Leaf-spot, clover, description	455	40
Legislation, chestnut-bark disease, Pennsylvania law	467	14–17
game, in 1911	470	3–15
novel features, 1911	470	5
need for control of chestnut-bark disease	467	11
quarantine against infested nursery stock, need	453	14–15
Leidigh, A. H., report on emmer growing at Channing, Tex	466	11
Lespedeza, description, value as forage crop, etc	455	37
stritiata, description, value as forage crop, etc	455	37
Lettuce, growing in frames, varieties, management, etc	460	19–20
packing for market	460	28
Lice, hog, remedy	465	20
Licenses, hunting and shipping game, United States and Canada	470	43–52
Lighthouse whitewash, recipes	474	20
Lime, chlorid, use for destruction of house-fly larvæ in manure	459	11, 13
use in potato growing	472	13
on alfalfa crop, management	472	29
land in truck growing	460	14
muck soils	457	8
red-clover crop	455	13
sour soil	451	7
Lime-sulphur dip for hog mange, preparation and use	465	19–20
Live-stock bloating treatment	455	24–55
farming, crop rotations suitable, notes	472	24, 25
feed, value of emmer	466	17
feeding, danger in root crops	465	16
velvet beans	451	14
Florida, forage supply, outlook, etc	457	8
infection from human excreta	463	12
raising in New Jersey	472	26–27
Locke, C. W., experiments in destruction of quack-grass	464	9–11
Locust, destruction by grosbeaks, note	456	12
Rocky Mountain, food of grosbeaks	456	9
Logged-off land, area in western Oregon and western Washington	462	5–6
burning over, management, etc	462	9–10
preparation for pasture	462	8–10
reforestation	462	7
utilization for pasture in western Washington and western Oregon	462	1, 20

	Farmers' Bulletin No.	Page.
Louisiana, game laws, 1911	470	19, 31, 37, 41, 47
Lucilia cæsar, description	459	6
LUMSDEN, L. L., and C. W. STILES, bulletin on "The sanitary privy"	463	1–32
Machinery, farm, for sterilizing soil	451	5–6
equipment of New Jersey potato farm	472	34–35
harvesting clover seed	455	32–33
Maine, game laws, 1911	470	11, 19, 32, 37, 41, 47
Mange, hog, treatment	465	19–20
Mangels, feeding to breeding animals, danger	465	16
Manitoba, game laws, 1911	470	14, 27, 35, 39, 42, 52
Manure, barnyard, care and use in potato growing	472	11–13
use in clover growing, caution	451	7–8
on corn	472	14–15
red clover, method	455	12
cow, increase of crop production per ton	469	12
value in relation to milk production	469	12
green, for potato growing in New Jersey	472	9–11
truck growing	460	14
value of velvet bean	451	11–12
production of dairy cows of different grades, value, amount, etc	469	12
sheep, value as fertilizer	457	19–20
stable, breeding place for house flies, control measures	459	10–14
regulations of District of Columbia	459	15–16
use in truck growing under frames, management, etc	460	14, 15
top dressing wheat for clover, management	455	45
treatment for destruction of house-fly larvæ, experiments	459	11–14
Marchal, Paul, guarantee of inspected nursery stock from France	453	14
Mares, care, etc	451	20–24
pregnant, care	451	20–21
Marketing capons, preparation, etc	452	13–14
crops grown in frames	460	27–29
lambs, winter-fed	469	9–10
potatoes	454	19
	472	21
sorghum hay	458	21
MARLATT, C. L., bulletin on "Danger of general spread of the gipsy and brown-tail moths through imported nursery stock"	453	1–22
Marsh lands, burning, management	465	7–8
soils, management	465	7–9
Martin, T. E., management of successful New York farm	454	1–32
Maryland, game laws, 1911	470	20, 32, 38, 41, 47
Massachusetts, game laws, 1911	470	11, 20, 32, 38, 41, 48
gipsy and brown-tail moths, efforts for control	453	10–11
moth depredations	453	15–16
Mayo, N. S., statement on sanitary care of swine in the South	465	17–20
McATEE, W. L., bulletin on "Our grosbeaks and their value to agriculture"	456	1–14
McDonnell, H. B., statement on purchase of fertilizers	457	7
Meat fly, description	459	6
Melilotus alba, description, value as forage crop, etc	455	37
METCALF, HAVEN, and J. FRANKLIN COLLINS, bulletin on "The control of the chestnut-bark disease"	467	1–24
Michigan, game laws, 1911	470	11, 20, 32, 38, 41, 48
Midge, clover-flower, description, damage, etc	455	38–39
Milch cows. *See* Cows.		
Mildew, downy, of cucumber, preventive measures	460	26–27
powdery, clover plant, description	455	40

	Farmers' Bulletin No.	Page.
Milk, city, cost of transportation and delivery	469	16
cost per pound in feed	469	14–15
market, cost	469	10–16
pail closed, value in sanitary milk production	457	20
pasteurizing, method	473	20–21
prevention of bacteria, methods	457	20–21
production, cost, statements of different dairymen	469	15–16
economic, individuality of the cow as factor	465	20–22
sanitary, production	457	20–21
skim. *See* Skim milk.		
tuberculous, use	473	20–21
use as starter in butter and cheese making, management	469	17–18
Milking, clean methods, importance	457	20–21
machine, care	457	21
Millet, growing as protection of grainfields from birds	456	13
Minnesota amber sorghum, description, value, etc	458	10
game laws, 1911	470	11–12, 20, 32, 38, 41, 48
Mississippi, game laws, 1911	470	21, 32, 38, 41, 48
Missouri, experiments in sheep feeding	457	19–20
game laws, 1911	470	12, 21, 32, 38, 41, 48
Montana, game laws, 1911	470	12, 21, 32, 38, 41, 48
Moth, brown-tail, damage to plants	453	22
description, seasonal history, etc	453	19–21
effect on health	453	11–12
property value	453	11
spread from imported roses	453	10
codling, food of grosbeaks, note	456	9
gipsy and brown-tail, danger of spread through imported nursery stock	453	1–22
gipsy, control measures, history	453	15–16
damage to plants	453	18
description, distribution, seasonal history, etc	453	15–18
destructive work in United States	453	15–16
effect on property value	453	18
egg mass on nursery stock in Ohio, note	453	6
introduction into United States, spread, etc	453	15–16
spread, manner	453	17–18
nests, brown-tail, description, number of larvæ, etc	453	6
imported on nursery stock, 1909–1911	453	5–7
Muck land, Japanese cane growing, management	457	8
Mulberry, value as protection of fruit from birds	456	13
Munson, T. V., system of training grapevines	471	22–23
Musca domestica. *See* House flies.		
Muscadine grape region, varieties grown, etc	471	29
Muscina stabulans, description, etc	459	6, 7
Nature study, forestry	468	1–43
in schools, object, scope, etc	468	5
Navel disease, foals, cause and treatment	451	23
Nebraska, game laws, 1911	470	12, 21, 32, 38, 41, 48
New Brunswick, game laws, 1911	470	14, 27, 35, 39, 42, 52
England, brown-tail moth, destructive work	453	18–19
control of gipsy and brown-tail moths, efforts, etc	453	10–11
Hampshire, game laws, 1911	470	12, 21, 33, 41, 48
Jersey Agricultural Experiment Station, influence on farming	472	8
farming systems	472	1–40
frosts, killing, 1901–1910	472	6
game laws, 1911	470	12, 21, 33, 38, 41, 49

	Farmers' Bulletin No.	Page.
New Jersey, precipitation, 1901–1910	472	6
soil types	472	5–6
Mexico, game laws, 1911	470	22, 33, 38, 41, 49
York farm, successful	454	1–32
game laws, 1911	470	12, 22, 33, 38, 41, 49
Newell, W., and M. S. Dougherty, description of cotton-stalk cutter	465	11–15
Newfoundland, game laws, 1911	470	15, 27, 35, 39, 42, 52
Newman, C. C., experiments in lawn making	469	5–6
Nevada, game laws, 1911	470	21, 32, 38, 41, 48
Nitrate, availability of nitrogen compared with other forms	465	5, 6
of soda, use in truck growing under frames, management	460	15
Nitrogen, cost of available	465	5–6
organic forms, availability, for plants	465	5
Nitrogen-fixing bacteria, functions, description, etc	451	8–9
North Carolina, game laws, 1911	470	12, 23, 33, 38, 42, 49
scuppernong growing for wine	457	15–16
truck growing under frames, relative magnitude of industry, note	460	9
Dakota Experiment Station, yield of emmer compared with other grains	466	19
game laws, 1911	470	13, 23, 33, 38, 42, 49
Nova Scotia, game laws, 1911	470	28, 35, 42, 52
Nurse crops for red clover, use, etc	455	16–18
Nursery conditions in Europe	453	12–14
stock, chestnut, cause of spread of bark disease	467	9
inspection of diseased	467	17–18
entry from United States to European countries, prohibition	453	15
foreign, introduction into the District of Columbia, danger, etc	453	8–9
imported, character and value	453	12
danger of spread of gipsy and brown-tail moths	453	1–22
inspection measures and need of laws	453	6, 14–15
infested, distribution of importations	453	6, 7, 8, 11
importations, 1909–1911	453	5–8
refuse, importations	453	14
Nuts, forest trees, study in primary grades	468	11–13
Oat crop, velvet bean as fertilizer	451	12
Oats, digestible nutrients	466	21
nurse crop for red clover	455	17
rotation with red clover, management	455	27–28
Ohio, game laws, 1911	470	13, 23, 33, 38, 42, 49
Oil, residuum, use in destruction of house fly	459	14
Oklahoma, game laws, 1911	470	13, 23, 33, 38, 42, 50
OLDYS, HENRY, C. E. BREWSTER, and FRANK L. EARNSHAW, bulletin on "Game laws for 1911"	470	1–52
Olive scale, black, food of grosbeaks, note	456	9
Ontario, game laws, 1911	470	15, 28, 35, 42, 52
Orange sorghum, description	458	7
value as forage in South	458	9
Orchard grass seed, amount to acre	462	11
value for pasture on logged-off land	462	11
heaters, use to ward off frost	460	19
importance on farm	454	25, 27

	Farmers' Bulletin No.	Page
Orchardists, chestnut, suggestions	467	20
western, value of grosbeaks	456	9
Orchards, damage by brown-tail moth in East	453	19
gipsy moth in East	453	18
protection from birds	456	13
Oregon, farm products, demand, etc	462	6–8
game laws, 1911	470	13, 23, 33, 38, 42, 50
western, and western Washington, utilization of logged-off land for pasture	462	1–20
Oster, George W., experiment in growing winter emmer in Pennsylvania	466	12
Ostertag system of rearing calves from tuberculous cows	473	21
Paint brushes, selection and care	474	6–7
use on farm	474	1–22
Painting metals, preparation of surfaces	474	12–13
on the farm, preparation of surface	474	9–13
Paints, colored, cost, composition, etc	474	16–19
composition and cost, general discussion	474	14–19
drying	474	7–9
mixing on the farm, directions	474	13–14
white, cost, composition, etc	474	15–16
Paris green, use against velvet bean insects	451	15
on potato crop	454	18
	472	21
Parrales system, training grapevines	471	25–26
Parrotbill, habitat, food habits, etc	456	12
Parrott, P. J., discovery of *Hyponomeuta padella* on imported nursery stock	453	6
Parsley, growing in frames, management	460	23
packing for market	460	29
Pasteurization, method for milk	473	20–21
Pasture, Japanese cane, management	457	9
mixtures for logged-off land	462	14–16
wet land, amount of seed, etc	462	14
plants for logged-off land	462	10–14
red clover, management, etc	455	24–25
utilization of logged-off land in western Washington and western Oregon	462	1–20
value of velvet bean	451	12
Pastures, constant use, effect on health of animals	463	7
management on logged-off land	462	16–17
permanent, mixtures suitable	462	15
quack grass destruction	464	9–11
Pea vine clover. *See* Clover, Mammoth.		
Peas, protection from birds	456	13
Pennsylvania, control of chestnut-bark disease, work	467	14–17
game laws, 1911	470	13, 24, 33, 42, 50
Peppers, growing in frames, note	460	24
packing for market	460	29
Perennial clover. *See* Clover, Mammoth.		
Phormia terrænovæ, description	459	6
Phosphate fertilizers, use on marsh soils	465	8–9
Plant growth, rapidity in sterilized soil, note	451	5
Planter sorghum, description	458	7
Planting, Japanese cane	457	9–10
potatoes, methods	454	15
	472	19–20
sorghum, directions	458	15–17
trees, study in schools, outline of work	468	19–21
Plow, for killing quack grass, description	464	9–11
ice, description	475	9
Plowing marsh soils, management	465	8
method for killing quack grass	464	9–11
lawn making	469	5

	Farmers' Bulletin No.	Page.
Plum scale, food of grosbeaks, note	456	9
Pollenia rudis, description	459	5–6
Pollinization, red clover blossoms	455	34
Pork-measle tapeworm, spread from excreta	463	12
Porthetria dispar. *See* Moth, Gipsy.		
Porto Rico, game legislation in 1911	470	13
Potato beetles, food of grosbeaks	456	7–8, 9
crop, cost and profits on New York farm	454	20–21
farms, income and expenses	454	22–24
	472	35–37
management	454	1–32
	472	30–38
growing districts, crop rotation, systems	472	8–30
New Jersey, importance of crop, etc	472	7–8
York farm	454	15–22
scab, effect of lime	472	13
seed, selection	454	16
	472	19–20
Potato-bug bird, habitat, food habits, etc	456	7–9
Potatoes, cultural methods, tools, etc	454	15–19
	472	18–22
fertilizing	454	16–17
	472	18–19
grades	454	16
growing continuously, management	472	9
marketing	454	19
	472	21
planting methods	454	16
	472	19–20
spraying	454	18–19
yield for 18 years, New York farm	454	21
in central New Jersey	472	22
Poultry industry in New Jersey, note	472	8
Powdery mildew, clover-plant, description	455	40
Prairie chicken, provision for open season in Illinois, note	470	5
Prince Edward Island, game laws, 1911	470	28, 35, 42, 52
Privies, different kinds, construction, advantages, cost, etc	463	13
insanitary, factor in spread of typhoid	459	11, 13
Privy, dry-system, description	463	15–16
sanitary, importance, construction, etc	463	1–32
the L. R. S., description	463	17–21
treatment to keep sanitary	463	30–32
wet-system, description	463	16–17
Propagation, grape, pruning and training	471	1–29
Pruning grapes, propagation and training	471	1–29
grapevines, directions for different seasons	471	13–16
Pseudopeziza trifolii, description	455	40
Purslane caterpillars, destruction by grosbeaks	456	12
Quack grass, eradication	464	1–11
land, types	464	6–8
rootstocks, description	464	6–8
Quail, export for restocking purposes, restrictions in North Carolina	470	4
Quebec, game laws, 1911	470	15, 28, 35, 40, 42, 52
Radishes, growing under frames, varieties, management, etc	460	21
packing for market	460	29
Ram, Down, cross with Southern ewe for spring-lamb production	457	17
Rape, feed for sheep, note	457	20
nurse crop for red clover, management	455	18
Rations, feeding lambs for market, experiments	469	9–10
Red clover seed, amount to acre	462	13
value for pasture on logged-off land	462	13
See also Clover, red.		
Red-amber sorghum, description, value, etc	458	10

	Farmers' Bulletin No.	Page.
Redbirds, habitat, food habits, etc	456	9
Red-chaff winter emmer, characteristics	466	23
Redtop, value for pasture on logged-off land	462	13
Reforestation, logged-off land, management, note	462	7
Refrigeration plant for farm, combined with ice house, plans	475	17–18
Refrigerator, construction, directions	475	18–19
Rhisoctonia violacea, disease of clover plant, note	455	40
Rhode Island, game laws, 1911	470	13, 24, 33, 39, 42, 50
Richardsonia scabra, value as forage crop, etc	455	37
Root borer, clover, description, damage, etc	455	37–38
crops, storage for feed	465	15–16
rot, disease of clover plant, note	455	40
tobacco, remedy	451	5
Roots, feed for sheep, note	457	20
feeding, danger to live stock, note	465	16
Rootstocks, nature, comparison with roots of plants	464	5–6
relation to leaf growth	464	5
Rose, B. E., statement on relative composition of different grades of fertilizers	457	5–6
chafer, food of grosbeaks, note	456	9
Rose-breasted grosbeak, habitat, food habits, etc	456	7–9
Russia, production of emmer	466	7
Rust, clover, description	455	40
Rye grass, English, comparison with Italian rye grass	462	12
Italian, amount of seed to acre	462	12
value for lawns, management, etc	469	6
pasture on logged-off land	462	12
nurse crop for red clover, management	455	16–17
place in rotation on potato farm	454	7
rotation with red clover, management	455	28
use with vetch as winter-cover crop	472	10–11
Sand, selection for concrete, preparation, etc	461	7–8
Sapling clover. *See* Clover, Mammoth.		
sorghum, description	458	8
Saskatchewan, game laws, 1911	470	29, 35, 40, 42, 52
Scale insects, food of grosbeaks, note	456	8, 9
Scenopinus fenestralis, description	459	7
Schools, study of forestry in nature work	468	1–43
Sclerotinia trifoliorum, description, note	455	40
Scott, J. M., statement on forage supply in Florida	457	8
W. G., directions for making whitewashes and calcimines	474	19–21
"Scouting," control of chestnut bark disease, work	467	12, 13
Scuppernong growing for wine making	457	15, 16
propagation, note	457	15
yield of wine per bushel	457	16
Seed, alsike clover, amount to acre	462	13
	472	23
bed, Japanese cane, preparation	457	10–11
red clover, preparation	455	12
sorghum, preparation	458	15
velvet bean, preparation	451	13
beds, tobacco, sterilizing, experiments	451	5–7
bur grass, destruction by grosbeaks, note	456	12
corn, treatment to prevent destruction by birds	456	12
cover crops, amount per acre	472	10, 11, 16
crimson clover, amount in mixtures	472	10, 11, 16
crop, red clover, estimation	455	32
harvesting	455	32–33
sorghum, destruction by sorghum midge	458	11
hairy vetch as cover crop, amount per acre	472	11, 16
Italian rye grass, amount to acre	462	12
orchard grass, amount to acre	462	11
pasture mixtures, amount to acre, and time of sowing	462	14, 16

	Farmers' Bulletin No.	Page.
Seed, potatoes, quantity per acre	454	16
	472	20
selection	454	16
	472	19–20
red clover, amount to acre	455	16
	462	13
characteristics of good and bad	455	9–10
cleaning	455	10
home-grown, advantages	455	9
production, handling, estimating, etc	455	30–34
selection and purchase	455	9–11
redtop, amount to acre	462	13
sorghum, improved, growing	458	21–22
inferior, note	458	12–13
scarcity, effect on sorghum production	458	11–12
selection	458	15
timothy, amount to acre	462	11
	472	23
velvet bean, selection, management, etc	451	13
white clover, amount to acre	462	14
Seeding clover, method	454	14
red clover	455	13–16
wheat, method	454	13
Seedlings, grape, use, note	471	5
Seeds, tree, germination, study in primary grades	468	14
Seivers, F. J., and A. R. Whitson, remarks on management of marsh soils	465	7–9
Semiarid regions, value of emmer	466	8–9
Sepsis violacea, description	459	7, 11
Service berry, use as protection of orchards from birds	456	13
Shaftal clover, description, value, etc	455	36
Shamel, A. D., invention of steam sterilizing machine for tobacco beds	451	6
Shearing, effect on sheep at different seasons	457	20
Sheep, feeding experiments	457	18–20
	466	17–18
	469	8–10
Florida, forage supply, etc	457	8
industry profits	457	20
raising early spring lambs in the South	457	16–20
shearing, effect at different seasons	457	20
turnips as feed, experiments	469	8
See also Lambs.		
Silage corn, growing in New Jersey	472	28
Japanese cane, cost, value, etc	457	9
Silo construction, cost, etc	457	23–24
	469	19–24
plastered, construction, value, etc	469	19–24
reenforced brick, construction, cost, etc	457	23–24
Sirup, Japanese cane, production per acre	457	8
Skim milk, proportion of whole milk	469	11
value per pound for different uses	469	11–12
"Slips," fowls, characteristics	452	12
SLOCUM, ROB R., bulletin on "Capons and caponizing"	452	1–16
Snow, removal, in harvesting ice	475	7
Soil, disinfection for "drop" disease of lettuce	460	26
fertility, methods for increasing	455	44–46
pollution, effect on health	463	7–8
of animals	463	7–8
sterilizing for "drop" disease of lettuce	460	26
truck growing under frames, preparation	460	14–15
Soiling crop, value of red clover	455	24
Soils, asparagus growing, management	469	7
Japanese cane growing, varieties suitable, management, etc	457	8–9
marsh, management	465	7–9
red clover	455	11–12
sterilization for tobacco seed, experiments	451	5–7

	Farmers' Bulletin No.	Page.
Sorghum "blast," cause, etc	458	11
classification and varieties	458	5–8
effect of crop on land	458	13
fertilizer, use of velvet beans	451	12
growing for forage, management	458	14–17
growth, factors limiting	458	11–12
hay, harvesting, curing, and marketing	458	13–14, 19–21
midge, destruction of seed crop, results, etc. *See also varietal names.*	458	11–12
sorghum-cowpea mixtures	458	17–18
Sorghums, growing period, yield, etc., of different varieties	458	6
nonsaccharin, distinguishing characters	458	6
varieties, etc	458	6–8
sweet, for forage, best two	458	1–23
South, advantages for sheep raising	457	16–20
Carolina, game laws, 1911	470	13, 24, 33, 39, 42, 50
Dakota, game laws, 1911	470	13, 24, 33, 39, 42, 50
Soy beans, rotation with red clover, management	455	29
Soy-bean hay, feed for sheep	457	18
Spelt, use of term for emmer	466	5, 6
"Speltz," use of term for emmer	466	5
Spontaneous combustion, red-clover hay, cause	455	23
Sprayer, potato, description	454	18
Spraying frame crops for insect control	460	27
potatoes, directions and cost	454	18–19
	472	36
Spur system, training grapevines	471	27
Stable flies, description	459	5, 6
fly, biting, description	459	5, 6
manure. *See* Manure.		
Stables, cow, suggestions for building, care, etc	473	22–23
importance of cleanliness	459	10
sanitation, regulations of District of Columbia	459	15–16
unsanitary, factor in spread of typhoid	459	10–11
Stalk cutter for cotton in boll-weevil districts	465	11–15
Starters, butter and cheese making, propagation	469	17–18
Stem rot, red clover, description, note	455	40
Sterilization, soils, for tobacco seed	451	57
Sterilizer, steam, for soil	451	5–6
STILES, C. W., and L. L. LUMSDEN, bulletin on "The sanitary privy"	463	1–32
Stomach worms, lambs, prevention	457	17–18
Stomoxys calcitrans, comparison with *Musca domesticus*	459	5, 6
Stool system, training grapevines	471	27
Storage, fruit, relation to ice supply	475	14–16
ice, principles	475	6–7
Storing sorghum hay	458	20
Straw, clover, utilization	455	33
use on wheat ground for clover	455	45–46
Sumac sorghum, description	458	6–7
value as forage in South	458	8–10
Sweet clover, description, value as forage crop, etc	455	37
Swine, sanitary care in the South	465	17–20
See also Hogs.		
Tapeworms, spread from excreta to animals	463	12
Teaching forestry in nature study, methods	468	7–8
Tenant farm, successful, New Jersey	472	30–38
Tennessee, game laws, 1911	470	13, 24, 34, 39, 42, 50
red clover growing, damage by anthracnose, remedies, etc	455	40–41
Test, tuberculin value, reliability, etc	473	19
Testing red-clover seed, method	455	11

	Farmers' Bulletin No.	Page.
Texas emmer growing experiments	466	10–11
game laws, 1911	470	13, 25, 34, 39, 42, 50
Thistles, occurrence in red clover, note	455	41
THOMPSON, HARRY, and BYRON HUNTER, bulletin on "Utilization of logged-off land for pasture in western Oregon and western Washington"	462	1–20
Tile, drainage, cost of laying, etc	454	11–12
Timothy, in mixture with red clover, management	455	26
	472	23
place in rotation on potato farm	454	7
	472	9
seed, amount to acre	462	11
	472	23
value for pasture on logged-off land	462	10–11
Tobacco beds, sterilizing, experiments	451	5–7
root rot, remedy	541	5
use on frame crops	460	27
Toe itch, cause	463	11
Tools, farm, equipment, potato farms	454	12, 13, 14, 16, 17
	472	34–35
for mixing concrete, cleaning	461	25
small, factor in successful farming	454	8, 28–31
"Tree doctors," warning	467	21
families, study in schools, outline of work	468	17–18
planting, study in schools, outline of work	468	19–21
study, differentiation from forestry	468	5–7
Trees, care and management, study in schools, outline of work	468	25
key to common kinds	468	39–43
study, in primary grades, outlines of work	468	10–16
Trellis training for grapevines, methods, management, etc	471	17–26
Trifolium hybridum, description, comparison with red clover, etc	455	36
medium, application to Mammoth clover	455	34
pratense. *See* Red clover.		
repens var. *lata*, comparison with red clover	455	36
suavolens. *See* Clover, crimson.		
Triticum amyleum. *See* Emmer.		
dicoccum. *See* Emmer.		
monococcum, origin and description	466	7
Truck crops in frames, control of diseases and insects	460	25–27
watering	460	16–17
growing, frames as factor	460	1–20
in frames, fertilizers, use and management	460	15
soil and fertilizers, management	460	14–15
Tuberculin, nature, preparation, etc	473	19
test, value, reliability, limitations, etc	473	18–20
Tuberculosis, bovine, nature, history, and importance	473	5–8
prevalence, spread, suppression, etc	473	1–23
sanitary methods for suppression	473	22–23
spread, means	473	7–8, 15–17
symptoms	473	8–11
cattle, suppression methods	473	20–23
caused by brown-tail moth	453	11
hog, prevalence	473	7
incubation period	473	19
spread by soil pollution	463	10
transmission from cattle to human beings	473	7–8
Turkeys, hatching and rearing by artificial methods	465	22–24
Turnips, nurse crop for red clover, note	455	18
value as feed for sheep	469	8
Twig-girdling insects, effect on chestnut trees	467	8
Typhoid fever, infection from house fly, note	459	8
	463	9
spread from excreta	463	8–10

	Farmers' Bulletin No.	Page.
Umbrella system, training for grapevines	471	22
Underbrush, destruction by Angora goat	462	17–18
Upland pastures, mixtures suitable	462	14
Uromyces, striatus, description	455	40
trifolii, description	455	40
Utah, emmer-growing experiments	466	12
game laws, 1911	470	14, 25, 34, 39, 42, 50
Velvet bean, growing in Florida	451	13–15
insect enemy, remedy, etc	451	14–15
value as crop, etc	451	10–15
beans, hay, cutting, curing, etc	451	14
Ventilation, frames used in truck growing, management	460	18
Veterinary, Association American Medical, report on tuberculosis	473	1–23
Voorhees, E. B., statement on cost of available nitrogen to farmers	465	5–6
Vermont, game laws, 1911	470	14, 25, 34, 39, 42, 50
Vetch, use as winter-cover crop, seeding, etc	472	10, 15–16
value as green manure for corn	472	15–16
Virginia, game laws, 1911	470	25, 34, 39, 42, 51
WALKER, PERCY H., bulletin on "Use of paint on the farm"	474	1–22
Warden service, results of game legislation in several States	470	7–8
Washington, D. C., danger from infested nursery stock	453	8–9
farm products, demand, etc	462	6–8
game laws, 1911	470	14, 25, 34, 39, 42, 51
western, and western Oregon, utilization of logged-off land for pasture	462	1–20
Watering lettuce in frames, management, caution, etc	460	26
truck crops under frames, management	460	16–17
Weatherproof white wash, recipe	474	20
Weed seed, destruction by grosbeaks	456	12
Weeder harrow use on dry farm	465	9–11
Weeds, eradication, use of velvet bean, note	451	10
red clover growing, preventive measures, etc	455	41
Weevil, clover-leaf, description, damage, etc	455	39
Weevils, destruction by grosbeaks	456	12
West Virginia, game laws, 1911	470	14, 26, 34, 39, 42, 51
Western grosbeak, habitat, food habits, etc	456	9–10
WESTGATE, J. M., and F. H. HILLMAN, bulletin on "Red clover"	455	1–48
Wet land, pasture mixtures, amount of seed to acre, etc	462	14
Wheat breeding, use of winter emmer	466	22
cultural methods on potato farms	454	12–13
	472	25–26
growing and harvesting on potato farm	454	12–13
	472	25–26
New Jersey, purpose, etc	472	8
nurse crop for red clover, management	455	16
place in rotation on potato farm	454	7–8, 12
	472	24–26
rotation with red clover, management	455	27–28
sowing, method	454	13
spring, in mixture with red clover, management	455	26
use as winter-cover crop	472	10
yields, New York potato farm, 1899–1910	454	13
Whitaker, G. M., statement on market milk production	469	15
White clover, comparison with red clover	455	35
value for lawns in South	469	5
Whitewash brushes, selection and care	474	6–7
disinfecting, recipe	465	20
factory, for interior, recipe	474	20

	Farmers' Bulletin No.	Page.
Whitewash, lighthouse, recipes	474	20
recipes	465	20
	474	19–20
weatherproof, recipe	474	20
Whitson, A. R., and F. J. Seivers, remarks on management of marsh soils	465	7–9
Williams, C. B., report on experiments with fertilizers on cotton	457	14–15
Wilson, James, report on investigation of prices of transportation and delivery of city milk, citation	469	16
Wine making, scuppernong, management	457	15–16
Window fly, description	459	7
Winter emmer, characteristics, value, etc. *See also* Emmer.	466	1–24
Winter-cover crops, potato growing in New Jersey	472	9–11, 15–16
Wire netting for protection of fruit trees, cost, management, etc	456	13
Wisconsin, game laws, 1911	470	26, 34, 39, 42, 51
Witch grass. *See* Quack grass.		
Wood, specimens, collection for forest museum	468	33–34
structures and uses, study in schools, outline of work	468	22
Woodlands, chestnut, advice to owners	467	20–21
Wyoming, emmer-growing experiments	466	13–16
game laws, 1911	470	14, 26, 34, 39, 42, 51
Yukon Territory, game laws, 1911	470	29, 35, 40, 42, 52
Zebra caterpillars, food of grosbeaks, note	456	9
Zigzag clover, Europe, note	455	34

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